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APPENDICITIS.

DESCRIPTION OF PLATE I.

FIG. 1.—Appendix removed twenty-nine hours after commencement of attack. Gangrenous and perforated at the distal extremity. The dark body in the cavity at the tip is a fresh blood-clot resulting from the involvement of one of the branches of the appendicular artery in the gangrenous and perforating process. The appendix, in this case, was unusually free from surrounding inflammatory conditions, adhesions, etc. The perforation had taken place into the unprotected peritoneal cavity and a violent septic general peritonitis was under way. No foreign body, or even inspissated fecal matter was present.

FIG. 2.—Appendix removed twelve hours after the commencement of the attack. The appendicular artery in this case extended to the distal extremity of the organ before giving off any branches. It was then reflected in the submucosa, and gave off its branches in a direction toward the base of the organ. The vessel is seen to be occluded by a thrombostasis a short distance from its tip.

FIG. 3.—External surface of an appendix imbedded in inflammatory material and perforated about half an inch from its distal extremity.

FIG. 4.—The same appendix incised longitudinally, the line of incision crossing the point of perforation. The wall of the appendix is shown, thickened at its upper or proximal extremity and about five-eighths of an inch from the latter. A stenosis exists, the cavity beyond which had undergone some dilatation The mucous membrane is seen to be gangrenous (green) and necrotic (yellowish-white) in spots. The larger perforation is shown in the broken line of the edge of the incised mucous membrane. Another and smaller perforation is present upon the opposite side and nearer the tip. This was a chronic relapsing case, operated upon in an acute relapse.

Plate I.

Fig. I.

Fig. II.

Fig. III

Fig. IV.

DRAWN FROM NATURE BY F. A. DECK.

A TREATISE

ON

APPENDICITIS.

BY

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TO THE MEMORY

OF

DR. ERNST KRACKOWIZER,

IN GRATEFUL RECOGNITION OF VALUABLE AID RENDERED TO ME EARLY IN MY PROFESSIONAL CAREER,

AS WELL AS

IN ADMIRATION OF HIS MANY NOBLE QUALITIES AS A MAN AND HIS SKILL AS A SURGEON,

THIS BOOK IS INSCRIBED.

PREFACE.

THE following chapters constitute a revised and corrected reprint of a series of articles which appeared in the ANNALS OF SURGERY under the title of "Observations upon Appendicitis."

The relation of the vermiform appendix to certain inflammatory conditions in the neighborhood of the cecum has been the source of careful and extended study on the part of surgeons during the last few years, this being comparable, to a certain extent, to the interest manifested at the beginning of the present decade in the inflammatory lesions of the Fallopian tubes and their consequences, when careful study of these brought out the truths which relegated to the musty pathology of the past such indefinite terms as "parametritis" and "perimetritis," as well as "pelvic abscess," and substituted therefore salpingitis and pyosalpinx. The interest awakened in appendical lesions, constituting as they do the most important inflammatory conditions of the abdominal cavity, in the male at least, has led to a steadily-increasing demand for definite knowledge of this, so far as known, useless organ and its diseases.

Exceptionally favorable opportunities have been afforded me, both in hospital and private practice, of observing the disease now known as appendicitis in its different forms. With the hope of shedding some light upon what has been, until quite recently,

one of the darkest chapters in surgical pathology, as well as to offer such observations upon the management of the affection as have been suggested as the result of a personal experience covering now nearly 200 cases of the disease, the present work has been undertaken.

The chapter upon the "Pathological Anatomy of the Appendix Vermiformis" is the work of Professor J. M. Van Cott, Jr. I desire also to express my obligations to Dr. Ezra C. Wilson, director of the Bacteriological Department of the Hoagland Laboratory, for valuable assistance in the preparation of the chapter upon "Bacteriological Considerations," and to Dr. H. B. Delatour for collating the original notes of the series of cases in my hospital service upon which the present study is largely based and preparing the index.

The lithographic illustrations are from colored sketches of the fresh specimen made immediately after removal by Mr. F. A. Deck.

Brooklyn,
302 Washington Avenue,
June, 1894.

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Fig. 1. Appendix removed twenty-nine hours after commencement of attack. Gangrenous and perforated at the distal extremity.

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Fig. 2. Camera drawing of nerve in transsection, also from the hyperplastic meso-appendix of chronic appendicitis.

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Fig. 1. Arteriole from an area of coagulation necrosis in a hyperplastic meso-appendix.

Fig. 2. Sclerosed arteriole, containing thrombus in granular degeneration.

Fig. 3. Arteriole from the submucosa of an appendix in which an acute attack supervened without perforation.

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A TREATISE ON APPENDICITIS.

CHAPTER I.

Anatomical Considerations.

The *caput cecum coli* is the large blind pouch which represents the initial portion of the colon. It is usually defined as that portion of the latter which lies below the level of the ileo-cecal valve. Its cavity measures somewhat more in the transverse than in the vertical diameter, being about two and a half inches in length, by three inches in breadth. Its usual location is in the right iliac region, lying upon the psoas magnus muscle, and its most dependent point or apex projects just beyond the inner edge of that muscle. This corresponds, externally, to a point slightly to the inner side of the middle of Poupart's ligament.

Occasionally the cecum will be found external to the psoas, and lying upon the iliacus muscle in the right iliac fossa; or the bulk of the caput may lie upon the latter muscle, while the apex rests upon the psoas. Again, the cecum may hang over the pelvic brim entirely clear of these structures, or be lodged within the cavity of the true pelvis. After the second month of intra-uterine life, the cecum gradually recedes from the neighborhood of the umbilicus, which is its original position, and finally becomes fixed in the right iliac fossa. Instances of non-descent of the cecum are not as infrequent as is generally supposed.

The condition of the cecum will determine, to some extent, its relation to the surrounding parts. Thus, when distended, it may occupy the entire right iliac fossa, crowding the small intestine toward the median line. In the empty state, on the

other hand, it is covered by loops of the small intestine, or these may even reach to its outer side.

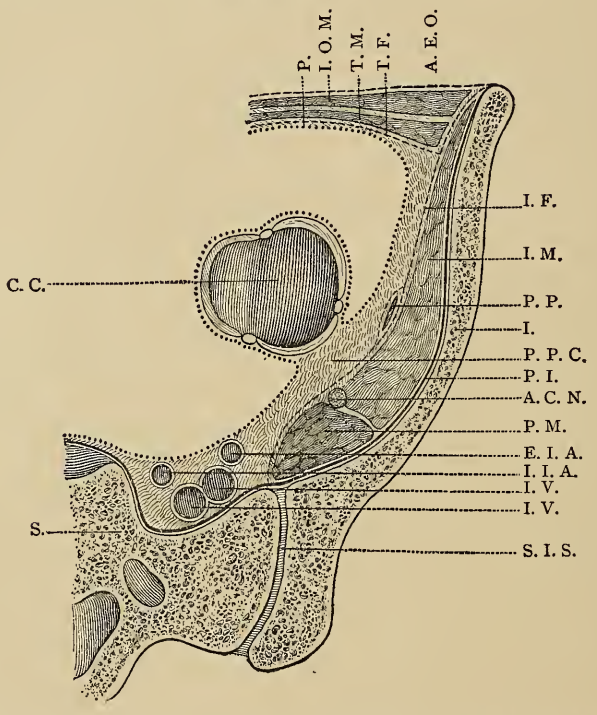

FIG. 1.—A transverse horizontal section through the pelvis at the level of the anterior superior spinous process of the ilium and sacro-vertebral angle.

Right Side.—Lower segment of the section. Adult male (after Tillaux).

C. C.—Caput Coli.
P.—Peritoneum (dotted line).
I. O. M.—Internal oblique muscle.
T. M.—Transversalis muscle.
T. F.—Transversalis fascia broken line).
A. E. O.—Aponeurosis of the external oblique muscle (broken line).
I. F.—Iliac fascia (broken line).
I. M.—Iliacus muscle.
P. P.—Psoas parvus.
I.—Ilium.
P. P. C.—Post-peritoneal connective tissue.
P. I.—Periosteum of the ilium.
A. C. N.—Anterior crural nerve.
P. M.—Psoas magnus.
E. I. A.—External iliac artery.
I. I. A.—Internal iliac artery.
I. V.—Iliac veins.
S. I. S.—Sacro-iliac symphysis.
S.—Sacrum.

The direction of the cecum is not in a straight line with the otherwise vertically placed ascending colon, but is somewhat obliquely placed from above downward and to the left.

The cecum is maintained in its position in the right iliac fossa by the posterior reflection of the peritoneum, leaving a variable portion of the posterior surface of this part of the large intestine applied against the iliac fascia, with more or less connective tissue (the retro-cecal connective tissue) between (Fig. 1). When a true mesocecum exists, this serves to connect the portion of the large intestine with the right iliac fossa.

The topographical anatomy of the cecum, particularly with reference to its relations to the retro-cecal and post-peritoneal

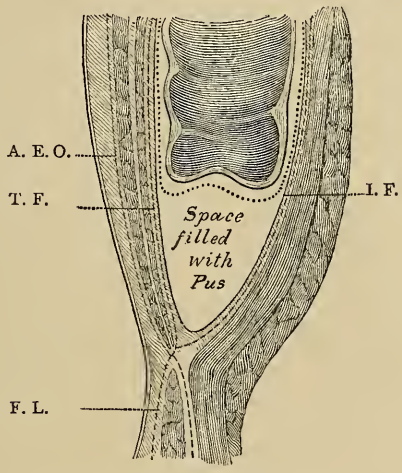

FIG. 2.—A. E. O.—Aponeurosis of the external oblique (broken line).
T. F.—Transversalis fascia.
F. L.—Fascia lata (broken line).
I. F.—Iliac fascia (broken line).
Purulent collection shown crowding the peritoneum (dotted line) in an upward direction, and limited below by the junction of the iliac fascia and the transversalis fascia at the crural arch (after Tillaux).

connective tissue, as well as the large vessels in the neighborhood, is of importance in connection with the inflammatory lesions of and operations upon the vermiform appendix. If a transverse and horizontal section be made through the iliac fossa upon a level with the anterior superior spinous process of the ilium and the sacro-vertebral angle, the average relative position of these parts in the adult will appear as shown in Figure 1.

The relation of the retro-cecal and post-peritoneal connective tissue is of especial importance in those cases of appendical abscess in which the appendix is only partially covered by peritoneum. Under these circumstances infection of the structures above named gives rise to a true iliac phlegmon (Grisolle). The suppurative process develops beneath the peritoneum and crowds that structure in an upward direction, as well as anteriorly. There is thus formed in the iliac fossa a collection of purulent material situated sub-peritoneally, the boundaries of which are as follows: In front, the transversalis fascia prevents its further progress in that direction, while the iliac fascia limits it posteriorly. The crural arch forms its boundary inferiorly.

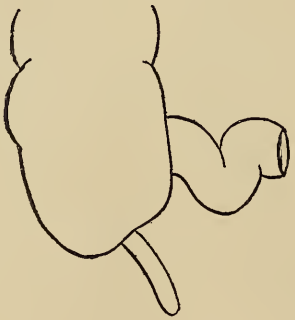

FIG. 3.

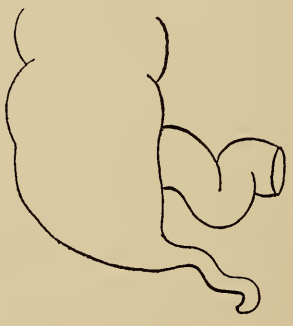

FIG. 4.

If the pus be not evacuated early it may find its way into the general cavity of the peritoneum by a process of ulceration,[1] after crowding this structure in an upward direction, as shown by the dotted line in Figure 2.

The passage of the external iliac artery and vein through the post-peritoneal connective tissue which forms the inner limit of the iliac fossa, offers an opportunity for the purulent collection to follow the sheath of these vessels and to make its appearance upon the anterior and inner aspect of the thigh. This occurs somewhat rarely in appendicitis, although one such case has come under my observation.

The appendix vermiformis ceci is an atrophied organ, the

[1] See page 112.

rudimentary remnant of the lengthened cecum found in all mammalia except man, and some of the higher quadrumana. It is also found in the wombat. It is usually attached to what was originally the apex of the cecum, close to the ileo-cecal valve on the inner and posterior side of the bowel (Fig. 3). Exceptionally the fetal type persists, in which case the appendix may become a continuation of the long axis of the colon (Fig. 4). In another form, the appendix appears between two bulging sacculi (Fig. 5); or, in still another, the root of the appendix is posterior to the inferior angle of junction of the ileum with the cecum (Treves), (Fig. 6).[1]

Instances of non-descent of the cecum result in a corresponding abnormal situation of the appendix; the latter has even

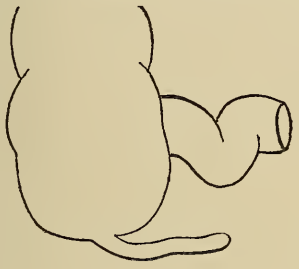

FIG. 5.

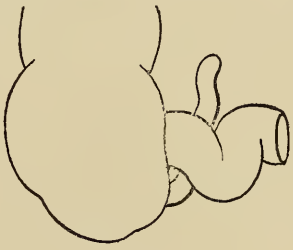

FIG 6.

been found lying to the left of the median line. Lennander mentions having observed in a dissection of a sixteen-year-old boy, the cecum, together with an appendix nine inches long, lying against the spleen in the left hypochondriac region.[2]

The length of the appendix varies from one to nine and a half inches; the average length is three and one-half inches. Its diameter is that of a goose quill. When a meso-appendix is present, this comes off from the left layer of the mesentery of the ileum, with which, together with the points of its attachment to the appendix, it forms two sides of a triangle; the third side of the triangle is formed by the free border of the meso-appendix. In 200 cadavers examined by Ferguson, of Toronto,[3] the appendix

[1] These variations depend upon the greater or lesser relative development of the dextral wall of the cecum.

[2] Sammlung klinischer Vorträge, No. 75, August, 1893.

[3] American Journal of the Medical Sciences, January, 1891.

in 100 cases was found to have a mesentery of its own. In the adult the mesentery extends from one-third to two-thirds of the length of the appendix, and a fringe-like prolongation reaches from this point to the tip of the organ. This is composed of two peritoneal layers, forming a fold between which considerable fat is sometimes deposited. This fold may sometimes enclose the iliac vessels as well. In the female the meso-appendix has a prolongation which is lost in the broad ligament; this is described by Clado as the appendiculo-ovarian ligament.[1]

The shape of the appendix varies greatly. It may be perfectly straight, particularly where the mesentery is very short or absent. The fact that the mesentery is frequently too short for the organ, often gives the latter a curved shape. Shortening of more than one portion of the mesentery may give to the appendix a lateral curve, a succession of curves, or a cork-screw (periwinkle) shape.

The structure of the appendix is similar to that of the large intestine, but is not identical with it. From without inward are to be found the following layers:

(1) The peritoneal investment of the organ. The completeness with which this covers the organ varies greatly. Sometimes it is entirely covered, as a finger is covered by a glove; in other instances it is but partially covered. The latter condition was found in more than one-quarter of the observations upon the subject which have been recorded, including those of Maurin, who, in the examination of 112 subjects, found the appendix in the entire number completely surrounded by peritoneum. In the remaining three-fourths the appendix was free in the peritoneal cavity. In those instances in which it is only partially covered by peritoneum, the uncovered portion is in direct contact with the post-peritoneal connective tissue.

(2) The muscular layer. This consists of a few long non-striated muscular fibres, with which are mingled a varying amount of fibrous tissue, constituting the outer portion of the muscular layer. The inner part of the muscular coat forms the greater portion of the walls of the appendix. It consists mainly of fine

[1] Société de Biologie, January 30, 1892; Revue de Chirurgie, March, 1892.

fibrous, with more or less muscular tissue, arranged in a circular manner. According to Austin Flint, circular muscular fibres do not exist in the appendix vermiformis.[1]

(3) A relatively thick layer of connective tissue, with arterial openings and lymphatic depressions—the sub-mucosa.

(4) A mucous coat, having a thin muscularis mucosa, and lined with cylindrical epithelium. The mucosa contains tubular glands and closed follicles. According to Clado, glandular structure is also found in the walls of the appendix in small areas of adipose tissue. A duplicature of the cecal mucous membrane near the orifice of the appendix, is sometimes described as a valve (Gerlach). This is not constant, and, even when present, forms but an incomplete valve.

The histological differences vary almost as much as the more readily recognized anatomical forms. The appendix is especially rich in lymphoid tissue, greatly resembling the tonsils in this respect. The proportion of lymphoid tissue may also vary greatly in different individuals, and in different parts of the same appendix. In some instances it is almost entirely absent. It is, as a rule, most abundant in children, although it is not by any means absent in the aged. Frequently the lymphoid tissue projects beyond the level of the mucous membrane, and encroaches upon the lumen of the organ. The mucous membrane itself is often built up of closely applied lymphoid cells, which are evidently undergoing the process of proliferation.[2]

The vermiform appendix has a central cavity or lumen, extending its entire length, which terminates in a *cul-de-sac* at its inferior or free extremity. The diameter of the central cavity is very small when compared with the thickness of its walls. The existence of a circular or semilunar shaped valve at the level of the cecal aspect of the appendico-cecal orifice, and which is supposed to guard the latter is denied by Clado. Lafforgue identified it in two out of 200 dissections (Testut), and in both of these appendices fecal masses occupied the cavity of the organ.

[1] Text-book on Human Physiology, New York, 1888, p. 258.

[2] A Contribution to the Pathology of the Vermiform Appendix. T. N. Kelynack, London, 1893.

This observation throws considerable doubt upon the assertion that the valve of Gerlach serves as a barrier to the entrance of fecal matter or foreign bodies into the appendicular cavity.

The blood supply of the appendix is as follows: Anastomosis takes place between the superior mesenteric, ileo-colic, right colic, and middle colic arteries by means of arches, from

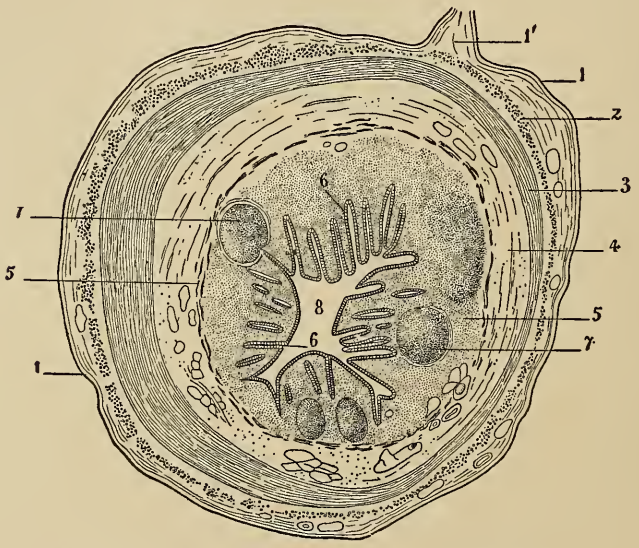

FIG. 7.—Section of the vermiform appendix (after Testut).

1. Peritoneal covering.
1¹. Mesenteric attachment.
2. Layer of longitudinal muscular fibres.
3. Layer of circular fibres.
4. Submucosa.
5. Mucous membrane.
5¹. Muscularis mucosa.
6. Glands of Lieberkühn.
7–7. Closed follicles.
8. Cavity of the appendix.

which secondary loops are given off; from the latter an appendicular branch arises in connection with branches which supply the ileo-cecal region. This appendicular branch, the essential nutrient artery of the organ, passes along the free edge of the mesentery, giving off branches on its way. In case the mesentery is absent, the artery passes beneath the peritoneal coat of the appendix. In exceptional cases the vessel may pass directly to

the tip of the organ, giving off no branches until it is reflected in the sub-mucosa.[1]

The lymphatics of the appendix pass into the appendicular lymphatic ganglion, which lies in the angle formed by the appendix and the cecum (Clado). In the female, lymphatic channels pass along the appendiculo-ovarian ligament, between the folds of the peritoneum which form this structure, and establish communication between the appendix and the ovary.

The nerves of the appendix are derived from the superior mesenteric plexus of the sympathetic nervous system. Filaments from the branch which accompanies the ileo-colic artery pass to the organ. It is to be noted that the superior mesenteric plexus is finally largely distributed to the small intestine. This explains the general dissemination of the pain in the abdominal region in cases of appendicitis.

The location of the appendix, with relation to the cecum, as well as to the general abdominal cavity and its contents, are important to the surgeon at the present time, in view of the fact that the removal of the organ (appendicectomy) has become an operation of frequent occurrence. Turner, of Moscow,[2] has made a careful study of eighty-three cadavers, in which the appendix lay freely in the abdominal cavity, with the following results:

In fifty-one, it hung down in the lesser pelvis.

In twenty, it passed transversely over the psoas muscle toward the sacral promontory.

In six, it lay freely upon the iliacus or upon the psoas.

In two, it passed upward upon the lateral surface of the descending colon.

In three, it lay in the meso-gastric region, with the commencement of the colon lying traversely.

In one, it lay in front of a right-sided sigmoid flexure.

In twenty-two cases in which the appendix lay behind the first portion of the colon, between this and the posterior abdominal wall, its relative position was as follows:

[1] See Plate I, Fig. 2.

[2] Chirurgitchesky Vestnik, 1892, March and May; Centralblatt für Chirurgie, No. 41, 1892, p. 840.

In four, it lay curled up behind the ileo-cecal junction.

In five, it lay directly behind the cecum.

In six, it passed intra-peritoneally along the posterior or postero-median surface of the colon.

In two, it passed in the same direction extra-peritoneally.

In four, it passed in the same direction, but only partly extra-peritoneally.

In one, the fundus of the cecum turned upward and backward, the appendix lying behind it.

Professor J. D. Bryant, of New York,[1] in a study of the location and direction of the appendix, based upon 144 dissections, gives the following tabulated statement.

Direction of the Appendix.	Male.	Female.	Not Stated.	Total.
Inward	20	11	3	34
Behind the cecum	18	10	4	32
Downward and inward	16	7	5	28
Into the true pelvis	14	3	4	21
Downward	5	0	0	5
Upward and inward	4	5	0	9
Upward and backward	3	0	0	3
Upward and outward	2	0	0	2
Outward	1	1	0	2
Upward along the inner side of the colon to liver	1	0	0	1
Upward outside of ascending colon and cecum	1	3	0	4
Curled below the cecum	1	0	0	1
Downward and outward	0	0	1	1
Upward and back of the cecum and colon	0	0	1	1
Totals	86	40	18	144

Dr. A. T. Bristow, one of my assistants at St. Mary's Hospital, has suggested a simple method of classifying the position and direction of the appendix. It consists in locating a central point in the right iliac fossa, and, from this as a centre, drawing lines radiating in the different directions that the appendix assumes, and representing its attachment to the cecum by the above-mentioned central point. The radiating lines are indicated by numbers. I have modified this method by substituting the ini-

[1] Annals of Surgery, February, 1893, page 164.

tial letters of the points of the compass for the numbers. A reference to the accompanying figure will show the application of the method. The line W. E. is drawn transversely to the median line of the body, and tangentically to the base of the cecum when in its normal situation. From the point where the cecum touches this line, the appendix may take any one of eight different directions indicated respectively by the radiating lines W., N. W., N., N. E., E., S. E., S., S. W. (Fig. 8).

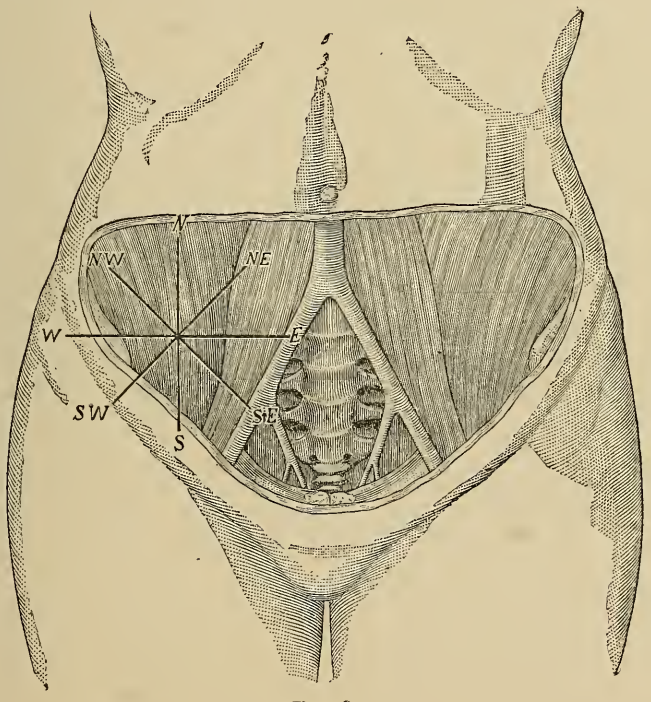

FIG. 8.

Appendices arising from colons abnormally placed form a class by themselves.

The appendix may pass either above or below the transverse line W. E. When above, it may take any one of the three general directions indicated by N. W., N. and N. E. If below the transverse line, it may in like manner take any one of the downward directions indicated by the lines S. W., S. or S. E. It

may also run directly dextrad in the W. direction, or directly sinistrad in the E. direction. When it takes the N. line it will usually lie behind the colon, although it may exceptionally take this direction anterior to the ascending colon. When the appendix takes the general direction E., if sufficiently long, it may cross both iliac vessels and appear in the left iliac fossa, where its presence may give rise to left-sided appendicitis. If the organ presents a decided inclination toward either the anterior or posterior abdominal wall, in either of these positions, the initial V (ventral) in the case of the former, or D (dorsal) in the case of the latter, may be added.

When the direction of the appendix is S. E., it very frequently passes across the vessels into the true pelvis. This point should be borne in mind when a differential diagnosis is to be made between appendicitis occurring in the female, and inflammatory conditions of the pelvic organs.

Adopting this method of classification and study, Dr. Bristow[1] reports the following as the position and direction of forty appendices in dissecting-room subjects:

Class A. Colon Normally Placed.

(1) Appendix above the transverse line:
Line N. W., 1; line N., 9; line N. E., 0; total 10.
(2) Appendix parallel with the transverse line:
Line W., 0; line E., 4; total, 4.
(3) Appendix below the transverse line:
Line S. W., 2; line S., 6; line S. E., 16; (not into pelvis, 1; into pelvis, 15); total 24.
Total number in Class A., 38.

Of these, one appendix, proceeding in the direction E., reached across to the left side, just beneath the linea semi-lunaris; one in the direction of N. just touched the liver.

Class B. Colon Abnormally Placed.

In the pelvis, 1; in the scrotum, 1. In each case the appendix lay behind the displaced colon.

[1] Meeting of the Brooklyn Surgical Society, April 6, 1893.

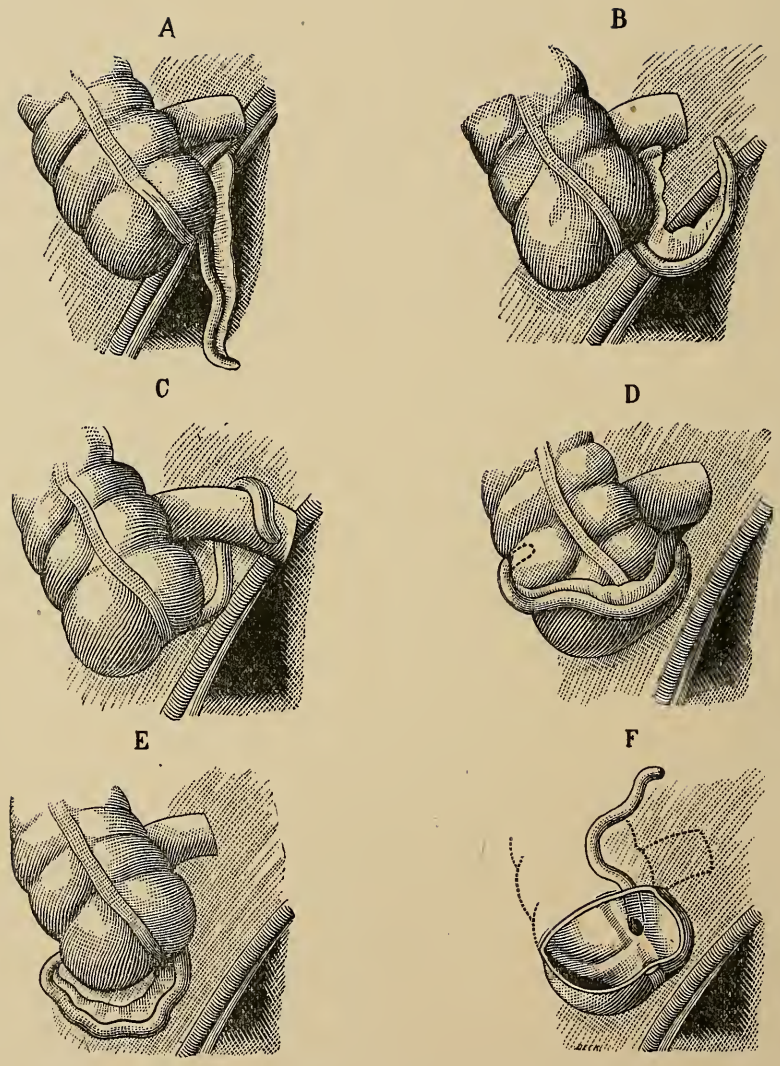

FIG. 9.—Showing the different positions of the vermiform appendix (after Testut).

A. Downward.
B. Inward.
C. Inward, coiled about the ileum.
D. Outward, crossing in front of the cecum.
E. Outward, upon the iliac fascia.
F. Upward, behind the cecum and colon.

M. Lafforgue's studies upon the relative frequency of these postions, as based upon 200 dissections of subjects at all ages of both sexes, gives the following results :[1]

In a downward direction, 41.5 per cent.; laterally, in an outward direction, 26 per cent.; laterally, in an inward direction, 17 per cent.; in an upward direction, 13 per cent.

Practically speaking, the appendix has four cardinal directions,—viz., (1) in a downward direction; (2) in a direction inward; (3) directly outward; and (4) in an upward direction. When it passes in the downward direction, in the great majority of cases the appendix crosses the psoas muscle and iliac vessels (A, Fig. 9) and enters the pelvis, where it is brought into relation with the bladder and rectum in the male, and in addition to these, in the female, with the uterus and right ovary.

In assuming the inward direction (B, Fig. 9) the appendix is brought into relation with the coils of small intestine and may even extend beyond the boundaries of the rectus abdominis muscle of the opposite side. Usually it runs parallel with that portion of the ileum which is adjacent to the ileo-cecal valve. Occasionally it is coiled about the ileum, at this point near the junction of the latter with the cecum (C, Fig. 9). In this situation, during an attack of inflammation, the appendix, by becoming attached at its tip to its own mesentery, may act as a constricting band and produces strangulation of the intestine.

When it passes in an external direction, it either crosses in front of the cecum, thus partially encircling the latter (D, Fig. 9), or it curves below the cecal ampulla (E, Fig. 9) and lies upon that portion of the iliac fascia which invests the iliacus internus muscle.

When it passes in an upward direction, it is attached to the posterior surface of the cecum (F, Fig. 9), and may extend behind the colon to the level of the kidney or even reach to the liver. A long appendix is generally less tortuous in its course than a short one.[2]

[1] Traité d'Anatomie Humaine, par L. Testut, Tome Troisième, 2e Fascicule, p. 543. Paris, 1893.

[2] The appendix does not assume the same direction at all times in the same individual.

Those who, in former times, were disposed to attribute to the appendix some important function based their views upon the fact that the organ was so attached to the cecum as to avoid the most dependent part of the latter; and was so located behind this, the pouch-shaped extremity of the colon, as to be out of the way of injurious influences, as well as to avoid the possibilities of the production of strangulation of intestine. Further, the supposed prevailing obliquely upward direction which it was believed was intended to prevent the entrance therein of fecal matter and foreign bodies, thereby assisting the action of the valve-shaped folds of cecal mucous membrane placed at its orifice or point of communication with the cecum, was urged in support of this theory. It is now known, however, that, as far as its position and origin are concerned, these, at least, are the natural result of developmental changes, involving, in intrauterine life, the forward and downward enlargement of the cecum. A diverticulum of the same width as the colon is at first formed; this widens out to form the cecum from a portion of the former, the lower part of the latter remaining as the comparatively narrow appendix. This at first presents a funnel-shaped communication with the large intestine (see Fig. 4). The broad base, however, gradually narrows before birth, although the appendix enlarges after birth. It increases in length and width actually, but becomes smaller relatively as the individual grows older. In other words, the appendix of an infant is larger, proportionately to the cecum, than that of an adult.

The fact that the appendix vermiformis is provided with follicles, both open and closed, like those of the cecum, has suggested some function in connection with these. This is met, however, with the argument that, if further glandular apparatus were needed at this point, the addition of a half inch more of cecum would accomplish the purpose without the risk involved in the present arrangement. In the case of the closed glands or lymphoid follicles particularly, the presence of which in the walls of a blind, narrow tube is believed to be of great pathological importance, a more dangerous morphological combination could scarcely be devised.

Investigations, therefore, upon the subject of the vermiform appendix only serve to emphasize the fact that, not only is it a useless organ, but a most dangerous one as well. The science and natural theology of but a few decades ago held the view that every species was of independent origin, and every structure designed for use in the organism within which it occurs. The student of comparative anatomy, however, whose studies extend beyond the domain of a single species will realize that there are structures in the animal economy the presence of which cannot be accounted for, or function demonstrated by the study of these in their relation to the organism within which they occur.[1]

The only course at all likely to throw light upon the vermiform appendix and its presence in man is by the study of the comparative anatomy of the cecum. This organ presents the greatest possible variation in the different species, in some of which it is of great length and enormous capacity, with the evident purpose of fulfilling an important function in connection with the processes of digestion and absorption. In man, as is well known, it is comparatively short, while in the otter, hedgehog and bat there is no abrupt distinction to be noted, externally, between the large and small intestine.

As a familiar instance of a largely developed cecum, may be mentioned the rabbit. In this animal the cecum is very long and capacious, being about the length of the animal, and of a capacity about ten times greater than the animal's stomach. The distal two and a half inches, or that part which is present beyond the spirally sacculated portion of the long cecum, has been compared to an appendix vermiformis. This portion is somewhat tapering in shape, the diameter gradually diminishing from about half an inch, where it commences, to three-eighths of an inch at its extremity. This portion is not sacculated ; its walls are thicker than those of the remainder of the cecum, and the latter are said to be the seat of a large number of closed glands or lymphoid follicles. This so-called appendix can scarcely be denominated a narrow tube, however, in the rabbit, for the reason that, in this

[1] Professor John Struthers, Edinburgh Medical Journal, December, 1893, p. 489.

animal it is really wider than the small intestine by an appreciable amount. A similar arrangement exists in certain vegetable-feeding marsupials, except that in these the appendical portion of the cecum is proportionately longer.

In certain long-tailed monkeys the ileum, colon and cecum closely resemble, in their arrangement and disposition, these parts in man, except that there is a progressive diminution in size of the large intestine, from the ileo-cecal region to the anus. The size of the entire digestive tract, although much smaller than in man, is larger in proportion to the size of the animal, than in the human subject. A dissection of one of these reveals the following :[1]

The large intestine, including the cecum, colon and rectum, measures sixteen inches in length. The colon, exclusive of the cecum, varied considerably in width at varying portions of the canal. At the level of the junction of the ileum with the cecum it was one inch in width; at two inches above this point the width was three-fourths of an inch; in the middle of the transverse colon it measured one inch; at the commencement of the descending colon it measured one-half an inch; at the sigmoid flexure it measured three-eighths of an inch. The rectum, just above the anal orifice, was but a quarter of an inch in width. The cecum itself measured one and a quarter inches in width. The width of the ileum at the point where it joined the large intestine was three-eighths of an inch.

The entire large intestine, commencing at a point one and a half inches below the ileo-cecal junction, is irregularly sacculated. It is made up of the usual large and small pouches, held together by the longitudinal bands and intestinal portion of the meso-colic attachments. At a point one and a half inches below the attachment of the ileum the sacculated condition suddenly ceases, from which point the intestine proceeds for a distance of three-quarters of an inch to a smooth and somewhat conical termination.

But two longitudinal bands are present at the cecal extrem-

[1] Specimen loaned by Dr. Eliza M. Mosher, whose courtesy is hereby acknowledged.

ity of the large intestine, the anterior and antero-lateral. Here and there, near the line of attachment of the meso-colon to the intestine, there is a suggestion of a third band. Both bands are considerably widened at their cecal commencement, as compared with their width elsewhere.

These longitudinal bands do not extend to the end of the large and smooth pouch, which represents the termination of the cecum, but are lost at a point corresponding to one and a half inches below the ileo-cecal junction, this being the exact point where the sacculated portion ceases.

A meso-colon is present, and likewise a meso-cecum. The latter ceases at the level where the longitudinal bands and sacculated portions of the large intestine cease. A triangular-shaped fold of peritoneum is given off from the last inch and a quarter of the ileum, which passes over, and is attached to a corresponding part of the terminating portion of the large intestine. This fold fills the angle below, formed by the junction of the ileum with the colon. As it extends downward upon that portion of the cecum below the point at which both the sacculi and longitudinal bands cease, it occupies almost exactly the location, as well as strongly resembles, the human meso-appendix.

The portion of the cecum below the sacculi and termination of the longitudinal bands is somewhat analogous to the condition of this portion of the large intestine, as it exists in early intra-uterine life in the human fetus. The smooth pouch, as distinguished from the more sharply defined and multiple sacculation, which represents the remainder of the cecum, the rather abrupt termination of the longitudinal bands at this point, as well as the presence of the triangular-shaped mesenteric fold existing in the angle between the cecum and the last inch and a quarter of the ileum, all seem to suggest that the lower portion of this unusually long cecum is really appendical in character, and forms that portion of the large intestine which, in the course of evolutionary changes, becomes vermiform. By processes of contraction and condensation the lower portion of the cecum assumes the shape which is found in the human subject. Its open glands

and lymphoid follicles do not disappear, in the course of these evolutionary changes, but are crowded more and more closely together, and hence become much more numerous, in proportion to the area which they occupy, than elsewhere in the intestine.

CHAPTER II.

The Inflammatory Lesions of the Appendix.

Definition and Classification.—The inflammatory lesions of the appendix were formerly comprehended under the terms typhlitis, peri-typhlitis and para-typhlitis. Typhlitis was defined as an inflammation of the cecum itself (Albers); the second indicated an inflammation of the parts immediately surrounding the cecum (Goldbeck); while the third was used to designate an inflammation of the post-peritoneal connective tissue of the cecum (Oppolzer). At the present time, thanks to the writings of Fitz, of Boston, and of Weir and McBurney, of New York, these diseases are very generally known to be due to lesions occurring primarily in the appendix, and extending thence to the peritoneal investment of the organ, or to the post-peritoneal tissue in the neighborhood.

To Grisolle is due the credit of having persistently opposed the teachings of Albers regarding the pathology of these affections. The views of the latter have found their way, however, into almost every text-book in which the subject is discussed since 1839, while the true pathology of the disease, although ably set forth by Grisolle[1] in the same year, was disregarded for more than half a century until brought to light and verified by the American observers just mentioned.

Grisolle contended that simple inflammation of the mucous membrane of the cecum could scarcely give rise to the grave consequences involved in the phlegmonous inflammatory conditions as they occur in the right iliac fossa, since dysenteric and other well-recognized forms of ulceration of the same structures show no tendency to extend into the neighboring connective tissue. On the other hand, inflammation of the vermiform appendix of the cecum, followed by perforation, phlegmonous

[1] Tumeurs phlegmoneuses des fosses iliaques, Archives de Médecine, 1839.

inflammation, and abscess in the right iliac fossa, explained in a rational manner the course of events as they actually took place; moreover, the explanation was verified by investigations carried out in the dead-house. The views of Albers were purely artificial and speculative, while those of Grisolle were based upon accurate anatomico-pathological researches.

The term "typhlo-enteritis," introduced by Burne, is equally objectionable as being misleading; this writer suggested that the term be applied to inflammation of the cecum and of the appendix as well.

The term "iliac phlegmon" simply implies one of the sequences of the disease, and in the light of our present knowledge, should also be rejected.

The possible appearance, though as a rare affection, of a genuine "stercoral typhlitis" is still maintained by Lennander. The occurrence of fecal stasis giving rise to an inflammatory paresis of the cecum, thus increasing the stagnation of the intestinal contents, and this in turn increasing the resistance offered by the inflammatory conditions, are supposed to be the pathological sequences involved in its occurrence. This view is opposed by Professor Sahle.[1] Unfortunately, abscesses which might be supposed to have their origin in this manner, are simply evacuated, the appendix, in all probability the cause of the trouble, being entirely disregarded. A case of intestinal obstruction observed by Lennander[2] indicates the possibility of its occurrence, but the question must still be considered *sub judice*.

In view of the prominent part that the appendix takes in these affections, if, indeed, it be not the structure exclusively involved in the primary lesions, it is deemed advisable to discard altogether the terms "typhlitis," "peri-typhlitis" and "para-typhlitis," as well as "typhlo-enteritis," as applied to the conditions usually met with, and to substitute for all of these the term "appendicitis" when speaking of the disease in a general way. Endoappendicitis is the so-called catarrhal form, while the name parenchymatous appendicitis (parietal appendicitis) is applied to

[1] Korresp. Blatt für Schweizer Aerzte, 1892, s. 593–611.

[2] Sammlung klinischer Vorträge, No. 75, 1893.

the variety of the disease usually developed from this by an extension of the inflammation to the sub-mucous connective tissue, and thence to the muscular layers. Ulcerative, gangrenous,[1] and suppurative forms also occur.

For clinical purposes it is convenient to divide the disease into the following-named stages, but the fact is always to be borne in mind that these stages may merge imperceptibly into one another, and that one or more stages may be absent altogether.

First Stage.—*Endoappendicitis.*—In this stage a more or less intense inflammation of the mucous membrane and submucosa occurs. The attack may advance no further than this stage. It corresponds to the stage of "appendicular colic," as described by Talamon,[2] and covers a period of about twenty-four hours. Talamon states that this stage is ordinarily prolonged from two to three days, and that it covers the period of the engagement of a stercoral calculus in the appendix. This is probably an error. I have more than once performed appendicectomy during the first forty-eight hours of the existence of the disease, and have never found evidences of this engagement of a coprolith at the cecal orifice of the appendix. On the contrary I have frequently failed to find even soft fecal masses within the appendix. Usually the most indubitable evidences of endoappendicitis, parietal appendicitis, or periappendicitis, or all three, are found even at this early period.

While it is true that this stage may represent only a so-called catarrhal inflammation, many physicians make the error of considering the condition as one of slight importance. In addition to the fact that the disease may run through all four stages within three days, and the first three stages within forty-eight hours, there are especially dangerous conditions that may supervene, or accidents that may occur, even when the inflammation seems to be limited to the mucosa and sub-mucosa.

The first of these dangers is the occurrence of constriction of some portion of the tube by the swelling of the mucous mem-

[1] See Plates I and II.

[2] Appendicite et Périty phlite par Ch. Talamon, Paris, 1892.

brane, and of the sub-mucous connective tissue. The parts first involved in the inflammation advance the most rapidly to the stage of engorgement and infiltration. As a result of this a constriction of the lumen of the appendix occurs, at one or more points, the effect of which is to imprison within what is now practically a closed cavity, the mucus resulting from the hypersecretion of the inflamed mucous membrane, together with whatever fecal matter there happens to be within the tube. As a further complication of this stage the pressure effects of the infiltrated connective tissue spaces of the sub-mucosa from without, and the accumulated secretion from within, should not be lost sight of. The appendix, like other vestigial structures in the animal economy which have ceased to functionate as a result of evolutionary changes, possesses but slight vital resistance. Interference with its blood supply to an extent that, in other organs would be of but minor importance, here produces the most disastrous consequences. These include necrosis of the mucosa, which invites rapid bacterial infection of the walls of the appendix; ulcerative destruction of a circumscribed character, which in its turn leads to a perforation from the presence of accumulated and retained mucus and muco-pus; finally gangrene of a portion or of the whole of the organ may develop.

Gangrenous inflammation may likewise result from a direct occlusion of the nutrient vessels of the body of the organ. As a result of an infection of the sub-mucosa an endarteritis or phlebitis, having their origin from the paravascular connective tissue spaces, occurs; the endothelial lining of the vessel then becomes roughened and thickened, and a stasis thrombosis follows. Certain anatomical peculiarities of the vessels themselves may favor the production of the gangrenous condition. For instance, it may happen that but a single nutrient artery exists, and that this may not give off any branches before reaching the tip of the appendix, being there reflected upon itself in the sub-mucosa. This condition was found to exist in one of my cases: a stasis thrombosis of septic origin occupied the lumen of the vessel at a point about one-third of the distance which the vessel traversed from the tip to the base of the organ. Endoappendi-

citis, engorgement of the vessels of the mucosa, capillary stasis, necro-biological changes in the mucosa, infection of the submucosa, endarteritis and thrombosis were all found to have taken place within ten hours following the first symptom of the disease. Under these circumstances the primary inflammatory lesion occurs in the peripheral portion of the organ, and the occlusion of the vessel takes place at this point; following this a gangrenous condition will supervene in the portion of the appendix lying between the point of occlusion and the base, since there is no other blood supply save through the reflected trunk.

Second Stage.—*Parietal Appendicitis.*—This stage is characterized by an inflammatory process, whose seat is in the interstitial or intermuscular structure of the body of the appendix. It is analogous to the corporeal metritis of the gynecologists. It presents in its simplest form an ordinary serous inflammation, with engorgement of the vessels, and the presence of an exudate in the perivascular spaces. The infection may take place through the sub-mucosa or through the lymphatic channels leading directly from the mucous membrane. As a result of circulatory disturbances (endarteritis obliterans), one or more circumscribed points of ulcerative action may develop, involving both the mucous lining and the peritoneal investment, and leading to perforation; or from interstitial pressure strangulation may occur in addition, and complete gangrene of the organ may follow.

Again, suppurative inflammation may occur in parietal appendicitis in the form of a rapidly spreading phlegmonous inflammatory process or several circumscribed points of suppuration the result of septic embolism. In this manner several foci of suppuration may make their appearance simultaneously.

Third Stage.—*Peri-appendicitis.*—A further step in the pathological process involved in this disease consists of an infection and consequent involvement in the inflammatory process of the peritoneum which invests the appendix. The limitation of the peritoneal infection to that portion of the serous membrane which covers the organ, with the occurrence of adhesions between the appendix and the serous surfaces immediately adjacent, mark the boundaries of this stage.

Fourth Stage.—*Para-appendicitis.*—In this stage the most serious consequences, arising from the presence of the disease, manifest themselves, although the dangers of the affection, as we have already seen, are by no means limited to this period. Following the formation of adhesions, infection of the fibrino-plastic exudate constituting these may take place, either through the lymph channels of the appendix, from perforation of the walls of the latter and infection from the walls of the tube, or by direct infection from one or more of the foci of suppuration in the walls of the appendix. Thus it may happen that, upon opening into an appendicular sero-purulent collection or abscess, the result of a para-appendicitis, the appendix may be found either perforated or intact.

Para-appendicular abscess, arising from suppurative inflammation in the retro-peritoneal connective tissue with which the uncovered portion of the appendix comes in contact, in cases where the organ is extra-peritoneally situated in whole or in part, also occurs in this stage of the disease.

Infection of the retro-peritoneal connective tissue, or of the mass of adhesions, or of both, in either of the ways above described, results in the occurrence of a suppurative inflammation within these. The suppuration may be limited to the adhesions themselves, and remain distinctly circumscribed, or it may assume a spreading, phlegmonous character here, as well as in the retro-peritoneal connective tissue. In the first instance, the formation of a sero-purulent collection, in the second, an abscess occurs with limiting walls, beyond which the peritoneal surfaces remain comparatively healthy (the " iliac phlegmon " of the older writers). With the formation of a spreading or phlegmonous inflammation the case is different. Here one of three things may result: First, a diffused peritonitis may take place, from septic infection, though the serous effusion following this need not necessarily become purulent. Second, a general suppurative peritonitis may occur from pyogenic infection of the serous effusion. Micro-organisms from within the intestine, which, under certain circumstances, may become exceedingly virulent, find their way to the seat of the effusion through

the usual channels of infection. In all probability these micro-organisms are themselves the infective agents which produce both the appendicitis and the peritonitis. The serum at once becomes a culture medium for the bacteria, and as a result of this a rapidly progressive suppurative process develops, followed by general septic infection. Third, secondary, encysted intra-peritoneal foci of suppuration may form. Here a serous effusion may occur beyond the limits of the original para-appendicitis, from localized peritonitis, due to indirect or lymphatic infection. The serum subsequently undergoes suppurative changes.

It should be stated, in passing, that the occurrence of septic peritonitis, either diffused non-suppurative, diffused suppurative or intra-peritoneal and encysted, is not necessarily limited to the fourth stage, or deferred till the formation of adhesions. From the first appearance of an endoappendicitis, channels of infection are opened which may lead to the occurrence of any one, or of all of the forms of septic peritonitis, without the occurrence of perforation, formation of adhesions or rupture of a sero-purulent collection or an abscess cavity.

The term "para-appendicitis" is sometimes employed to designate suppurative inflammation of the connective tissue adjacent to that portion of the appendix which is not covered with peritoneum, when this anatomical condition exists. Inasmuch as this condition is exceptional, while suppurative inflammation of the connective tissue and inflammatory new formation about the appendix is of very common occurrence, the term is here employed as a convenient one to designate both conditions. In the case of the connective tissue, ordinary pus is produced, while in the case of the mass of adhesions, an intra-peritoneal sero-purulent collection results.

Circumscribed inflammatory processes within the peritoneum do not, as a rule, show the same tendency to spread from the very beginning as do those occurring extra-peritoneally. In the case of the latter the entire plane of connective tissue of the dorso-lumbar region may become rapidly infected and as a result of this lumbar phlegmon, a subphrenic or a paranephritic abscess may arise from lesions of the appendix.

In pursuing the study of the clinical history of the disease, it becomes at once apparent that it presents itself with different degrees of severity, from the acute form on the one hand, the different stages of which have just been discussed (the hyperacute form of Talamon), to the subacute form on the other, with its slight febrile action and moderate abdominal pain and tenderness. In addition to these, there are different phases of the disease to be noted clinically. These consist of the recurrent form, and of the chronic form, which in its turn may lead to the relapsing variety.

CHAPTER III.

Acute Appendicitis. Clinical History.

In the great majority of cases the clinical course of the disease is characterized at the outset by the occurrence of acute abdominal pain. While the term "appendicular colic" (Talamon) has been given to this acute pain, I consider this misleading, and liable to give rise to indifference on the part of the medical attendant to the true conditions present, and the dangers which threaten the patient. The term "colic" has been generally applied to purely functional disturbances of the large and small intestines; the acute pains of appendicitis are due, on the contrary, to an inflammatory condition, which may rapidly involve the entire organ, and place the patient's life in the greatest jeopardy. If the colic be of appendicular origin, an appendicitis in one of its forms is already in progress.

The view that the "colic" is produced by an attempt on the part of the appendix to rid itself of fecal matter which has found its way into the tube, is refuted by the frequency with which fecal matter, sometimes even in the shape of coproliths, is found post-mortem in cases in which no colic had occurred; and by the fact that as a rule no circular muscular fibres are present in the appendix, or when present, are in insufficient quantity—hence efforts at expulsion would be very feeble in character, and not calculated to give rise to the violent pains characteristic of the first stage of appendicitis.[1]

The attempt to compare the mechanism of the production of pain during the first stage of an attack of appendicitis to that which takes place in the initial stage of a hepatic, or of a nephritic colic, by supposing that a hard mass of fecal matter engages in the orifice of the tube is equally fallacious. In the case of hepatic or of nephritic colic the offending body is either a gall-stone or an

[1] Prof. Austin Flint is authority for the statement that there are no circular muscular fibres in the appendix, while Kelynack asserts that they are present in varying amounts. Their presence, according to Prof. Van Cott, is frequently demonstrable.

uric acid or oxalate of lime calculus, and there can be no question as to the ease with which these may produce local as well as radiating pains, with constitutional disturbances. In the case of the appendix the pains cannot be explained in this manner. Here the fecal matter, when present, is so soft as to be readily crushed between the thumb and finger, as I have repeatedly demonstrated to visitors at my clinics. The presence of these soft fecal masses in appendices exposed in laparotomies done for other purposes, which can be readily felt upon palpation, and to which I have often called the attention of my assistants, also effectually disposes of the fancied similarity between an attack of appendicitis, and an attack of renal or of hepatic colic, even if the entire absence of fecal concretions, and other foreign bodies in a large proportion of cases of the disease under discussion, was not of itself sufficient.

In view of these facts, therefore, the sudden occurrence of sharp colicky pains should always direct the attention of the practitioner to the appendix vermiformis, and a watchful care should be exercised over this apparently useless, and certainly treacherous, organ.

The location of the primary pain is usually referred to the neighborhood of the umbilicus. Next in frequency it is complained of in the epigastrium, very infrequently in the region below the umbilicus, and least frequently of all is it referred to the appendix itself. With the advance of the disease, and the occurrence of localized peritonitis, the pain is referred, in addition, to the right iliac fossa, or at this stage the latter may be the sole seat of the pain. The fact that the pain is so seldom located about the cecum in the commencement of the disease is, in a large measure, responsible for many errors which have been made in the diagnosis.

It is difficult to find a suitable explanation of this peculiar phenomenon. I have observed, however, in a case of artificial anus involving the cecum and the first two inches of the ileum, that the application of the compressing enterotome of Dupuytren produced the same acute pains referred to the region of the umbilicus. Bacon, of New Haven, in a case in which he was

compelled to remove the appendix under cocaine anesthesia, remarked that the patient complained of pain about the umbilicus when the organ was grasped by a pair of forceps. In the case of the compressing enterotome the pain was doubtless produced by the blades of the instrument grasping the base of the appendix, as one of these passed into the cecum, and the other into the ileum. When the blades were readjusted, and passed in an upward and inward direction, away from the appendix, relief of the peri-umbilical pain followed.

Coincidently with the attack of pain, or shortly thereafter, nausea and vomiting frequently occur. The appearance of these symptoms, in connection with pain about the umbilicus, is significant, in spite of the generally received opinion that the nausea and vomiting are only such as are frequently observed in ordinary attacks of acute indigestion, and which usher in many of the acute diseases. Even where indigestion and intestinal colic are responsible for the nausea and vomiting, the nausea is more apt to precede than to follow the colicky pains, as in appendicitis. The vomiting is a purely reflex symptom, due to an irritation having its origin in the appendix.

The vomiting is rarely persistent during the initial stage of the disease. It usually ceases when the contents of the stomach are evacuated, but may return with the occurrence of perforation of the appendix, rupture of an encysted sero-purulent collection, or of an appendicular abscess, or the condition of intestinal paresis. If nausea alone be present it is rare for it to last beyond the first two or three hours of the disease. The character of the vomiting in cases where it recurs after having once ceased, will vary according to the conditions present. If coincident with primary perforation of the appendix itself, or following it, when no adhesions have formed, or with rupture of an appendicular abscess into the peritoneal cavity, the vomiting will be explosive, and the material evacuated from the stomach of the greenish serous character so common in general septic peritonitis. In intestinal paresis stercoraceous material may be ejected, in addition, as a result of a reversed peristalsis. When the intestinal tube is emptied, serous fluid which has gained access to the intestine from

the peritoneal cavity by endosmosis, will be ejected more or less stained by its passage along the intestine (fecaloid vomiting). During the first stage of the disease the patient may swallow more or less fluid without necessarily provoking vomiting, or even increasing the nausea. The vomiting which occurs in connection with perforation differs from this in that it is prolonged, incessant, and repeated, and is aggravated or provoked by any attempts to take medicine, or even small quantities of food or liquids.

Constipation may precede or accompany the attack. Obstinate constipation occurring in connection with the commencement of the attack is indicative of early intestinal paresis, and should be a warning to the attendant that he has to deal with a more than usually grave form of the affection. When this symptom appears later in the course of the disease, its character does not differ from that which occurs in the course of peritonitis due to perforation by other causes. Finally, this symptom may assume all of the characteristics of the obstipation which accompanies intestinal obstruction; namely, progressive distention, inability to pass gas per rectum, and the appearance of the shape and movements of the coils of intestine, which can be observed when the abdominal walls are sufficiently thin.

Tenderness in the right iliac region is an early and a marked symptom. While there may be more or less diffused tenderness in the fossa, it will usually be easy to indicate the site of the appendix by a correspondingly increased amount of tenderness at a particular spot. The usual location of the appendix will be found to be at the dextral edge of the right rectus abdominis muscle, at varying distances below a line drawn from the centre of the umbilicus to the anterior superior spinous process of the ilium (the omphalo-spinous line). The location of this point of tenderness will vary somewhat with the location of the appendix and its relation to the external surface of the abdomen, with the length of the appendix, and with that portion of the long axis of the organ which is primarily the seat of the disease. It is manifest at a glance that an exceptionally long appendix, having its attachment to the cecum normally placed, and the latter in the usual anatomical position, may, by becoming the site of an in-

flammation at its tip, give rise to very acute sensitiveness upon pressure at a point remote from the right iliac fossa, and at the same time the right iliac fossa be free from tenderness altogether. With an especially early and extensive involvement of the post-peritoneal connective tissue, there may be marked tenderness in the loin.

In the early stage of the disease tenderness is only elicited when pressure is made in the immediate neighborhood of the appendix itself. With the formation of adhesions about the organ the adjoining coils of small intestine, the ascending colon, the cecum and frequently more or less of the overlying omentum, become matted together and fixed about the site of the original peritoneal inflammation. As a result of this, pressure upon other portions of the abdominal surface, by disturbing the underlying parts, will sometimes cause these in their turn either to drag or to press upon the parts involved in the focal point of inflammation. Symptoms of tenderness in the right iliac fossa will thus be elicited, if the portion of the appendix originally involved lay in this region.

In such cases, where the inflamed portion is located remote from the usual position of the base of the appendix, this symptom, like that following direct pressure, will usually be referred to the point of focal inflammation, wherever that may be.[1]

In case of displacement of the cecum from a short mesocolon, or because of the persistence of the early fetal state the symptom of tenderness, as well as all other symptoms, may be entirely removed from the right iliac fossa and be transferred to the umbilical region, or even beyond this to a point beneath the left rectus muscle (left-sided appendicitis). Three instances of left-sided appendicitis have already been reported by the author.[2]

The first of these was a young woman, who was suddenly attacked with colicky pains, which were thought to be due to

[1] To this rule, however, I have observed occasional exceptions. With the appendix located quite remote from McBurney's point, I have still found the point of maximum tenderness at the latter.

[2] See Medical News, Philadelphia, November 25, 1893, p. 604.

intestinal colic. A point of tenderness existed at the outer border of the left rectus muscle, on a line with the umbilicus. Perforation took place on the third day, and the patient died. The autopsy revealed a perforated left-sided appendix, the cecum being located behind the umbilicus, and an abdominal cavity filled with sero-purulent fluid and fecal matter.

A second case was that of a young male, who was admitted to St. Mary's Hospital on the seventh day following a sudden attack of general abdominal pain followed by vomiting. The pain had been at no time localized. The physician in attendance had made out a tumor beneath the left rectus muscle, and, believing this to be the result of fecal impaction, cathartics had been administered. The tumor disappeared, although the bowels did not move; the pains increased in severity, and the patient became greatly prostrated. A median abdominal section was made at once. The abdominal cavity was found to be the seat of a large amount of sero-purulent fluid and fecal matter. The caput coli was found immediately behind the umbilicus, the cecum was turned to the left, and the appendix lay behind the left rectus muscle, just below the level of the umbilicus. The patient's condition did not admit of an attempt to remove the appendix, but the autopsy showed this to be gangrenous and perforated.

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The third case was also that of a young male, who was seen by me in consultation with Dr. Burge, upon the third day following a sudden attack of severe abdominal pain, which had been followed by nausea and vomiting. Tumor, marked tenderness and dulness on percussion existed in the left iliac region. Left lumbar sensibility was likewise marked. The temperature was 104° F., and the pulse 124. A diagnosis of left-sided appendicitis was made, and he was removed to the Methodist Episcopal Hospital for operation. A median abdominal section revealed a large sero-purulent collection free in the peritoneal cavity, and an abscess cavity in a mass of adhesions, which communicated with a second large abscess cavity in the post-peritoneal connective tissue. The patient's condition did not admit of prolonged search for the appendix, but two days afterward a post-mortem examination of the parts revealed this to be gangrenous

and perforated, and imbedded in the mass of adhesions located in the middle of the left iliac fossa, which had been the site of an appendical abscess. The ascending colon was situated to the left of the colon, and the cecum was at the level of the umbilicus.

Unless the possibility of this or some other anatomical abnormality is borne in mind, the entire train of symptoms will be misinterpreted, the true nature of the disease present may not be recognized and death may follow.

In palpating the surface of the abdomen while seeking for localized tenderness, the surgeon will note in some of the cases a certain amount of rigidity of the rectus abdominis muscle corresponding to the site of the primary focus of inflammation. This, as a rule, will be upon the right side. The symptom will be pronounced in proportion to the involvement of the corresponding portion of the parietal peritoneum. For instance, it will be well marked in those cases in which extensive adhesions form anteriorly, as in the matting together of the appendix, the anterior surface of the ascending colon and cecum, and the overlying omentum. On the other hand it may be entirely absent in the early stage of the disease, before the formation of any adhesions, or late in the disease, when the adhesions which form are placed posteriorly to the appendix. Furthermore, absence of this symptom is not to be accepted as evidence against the existence of appendicitis, for in those cases in which the appendix passes into the pelvis, or is directed posteriorly and passes directly upward behind the cecum, that portion of the parietal peritoneum corresponding to the rectus muscle may not become involved in the inflammation until late in the disease. Finally, the occurrence of an encysted sero-fibrinous or fibrino-suppurative peritonitis following upon an appendicitis in which the abdominal wall forms a portion of the environment of the collection of fluid, will cause rigidity of the overlying muscular structure. General peritoneal inflammation will cause tension of all of the muscular structures of the abdomen.

As the disease advances, tympanites from paretic distention of the adjacent coils of intestine takes place. Stokes has called

attention to the disturbances of function of portions of the intestinal tube that border upon structures which are the site of progressive inflammatory processes. With the spread of the peritoneal inflammation the coils of the intestine in the vicinity become more and more distended, and new ones become involved in the paretic condition. The effect of this will be to cause a bulging of the right as compared to the left iliac fossa, although this symptom may also result from the presence of an abscess cavity or an encysted sero-fibrinous or fibrino-suppurative exudation.

It is somewhat rare for the tumor itself, which is made up of the appendix and a mass of adhesions, to produce the bulging or prominence in the right iliac fossa just mentioned, unless suppuration has taken place. This bulging may occur, however, in very thin subjects.

Other symptoms present themselves, according to the position of the appendix and the part involved in the inflammation. More or less irritability of the bladder from peri- or para-cystitis occurs in those cases in which a long appendix passes into the pelvis and lies adjacent to the bladder at the time of the attack. Among these somewhat rarely observed symptoms are also to be mentioned retraction of the thigh, or partial flexion of the latter upon the trunk. This symptom is sometimes, although not invariably, observed in those cases in which the inflamed appendix rests upon the posterior layer of the parietal peritoneum, corresponding to the flexor muscles of the thigh. The retro-peritoneal connective tissue, and finally the sheath of the muscle, may, under these circumstances, become involved by extension through the iliac fascia which separates the peritoneum from the muscles. The latter become disturbed functionally through interference with their nerve supply, and as a result their points of insertion are approximated and the symptom under discussion is produced.

The occurrence of a chill during the first stage of the disease is only occasionally noted, even in cases of more than usual severity. In certain cases it marks the occurrence of suppuration. Neither the severity of the primary attacks nor

the gravity of the subsequent lesions seems to bear more than a casual relation to the occurrence or pronounced character of this symptom.

The temperature and pulse vary in different cases, although they do not by any means bear a constant relation to the gravity of the attack. Generally speaking, an early and considerable elevation of temperature and rapid pulse rate accompany a high degree of inflammation, with tendency to early perforation or gangrene; but the reverse does not hold true. I have known perforation to occur before the formation of protecting walls of adhesions, with a pulse of 80 and a temperature of 99° F.

During the first stage of a case which is to follow the average course there will be an elevation of temperature of from one to three degrees Fahrenheit. This moderate elevation of temperature is apt to be misleading to the medical attendant. Failure to recognize the exact degree of inflammation of the appendix itself during the early stage of the affection would be of but very little moment were it not for the possibilities of perforation occurring prior to the formation of adhesions and consequent septic peritonitis; or the dangers of septic infection of a profuse sero-fibrinous exudate (suppurative peritonitis) without perforation, as well as the infection following the lymphatic vessels of the peritoneal investment of the appendix and thence to the general peritoneum.

A remission of all the symptoms of the first, second and third stages, save local tenderness, may take place, and yet the disease pass steadily onward through all its stages to a fatal termination. *A lowering temperature and lessening pulse-rate are not inconsistent with impending ulceration, perforation of the appendix into an unprotected peritoneal cavity, complete gangrene of the organ, or rupture of an appendicular abscess into the cavity of the peritoneum.*

The occurrence of diffused, followed by septic or suppurative peritonitis, will be announced by increased abdominal pain (unless this symptom be masked by the administration of opium), slowly increasing distention and progressive prostration. The pulse and temperature likewise indicate the occurrence of this

condition; the former by gradually increasing rapidity, and a correspondingly lessened force, and the latter by a gradual, but decided elevation; this rise is frequently followed by a fall which may reach a subnormal point. The features become pinched and drawn and the eyes sunken. The surface of the body, particularly the extremities, becomes a bluish color, cold, and often bathed in a most profuse perspiration. Vomiting, which may have been present previously and copious, becomes scanty. The patient maintains a position upon his back, with the knees drawn up. The muscles of the abdomen are tense, and the latter is usually flattened rather than rounded. The respirations are short and rapid; hiccough is sometimes present at the very last. Albuminuria, with the presence of indican, are marked features; total suppression of the renal secretion may occur. The constipation is intractable.

If the intra-peritoneal sero-purulent fluid is encysted, the symptoms will be less urgent. From time to time there will occur acute attacks of pain, fever and vomiting, while the symptoms present a series of alternating exacerbations and remissions. The exacerbations under these circumstances are due to an occasional extension of the area of inflammation involved in the original focus, and perhaps an increase in the quantity of the encysted fluid which forces back the adhesions, and gives rise to new plastic exudation. The temperature does not become subnormal, but, on the contrary, may be higher than in the general suppurative form. The facies abdominalis is less marked, and the pulse is less rapid and feeble. The skin maintains its normal heat and color. The perspiration is less profuse, and may be absent altogether. There may be vomiting from time to time. The renal secretion is not suppressed, although, perhaps, scanty. Neither albumen nor indican are present as a rule.

A marked difference in the two forms of the affection will be found in the appearance of the abdomen. In the diffused septic form it seems as if the entire intestinal tube was completely paralyzed at the very outset, and that absolutely no intestinal gas found its way into the canal. As a result of this, a flattened appearance of the belly follows. On the other hand, in the

encysted variety, only those portions of the intestinal canal that come within the influence of the inflammatory area are disturbed in their functions, and then not to the same extent as in the fulminant form. These portions, in consequence, will become distended by gas forced into them from the still functionally active portions of the canal, and tympanites, or marked meteorism, will become a more prominent feature of this variety. The abdomen will become more and more rounded, and finally barrel-shaped.

The contents of an appendicular abscess may find their way into an adjoining coil of small intestine, thus forming a communication between the cavity of the intestine and that of the appendix itself. In a case of chronic relapsing appendicitis seen by me in consultation with my colleague, Dr. L. S. Pilcher, at the Methodist Episcopal Hospital, this condition was revealed at the operation. In addition, the appendix was found to be the seat of a stenosis, which shut off the distal third of the cavity of the organ, which originally had been the site of a cystic dilatation and perforation. An interchange of contents between the cavity of that portion of the ileum which lay immediately adjoining the appendix and that of the latter, as well as the abscess cavity itself thus took place, leading to a reinfection of the latter, and an occasional relapse of the symptoms.

Spontaneous extra-peritoneal evacuation of the abscess occurs in a certain proportion of cases. The evacuation takes place comparatively seldom in the direction of the anterior abdominal walls. It may take place posteriorly, the purulent infiltration thence finding its way along the psoas muscle to the thigh; or it may follow the line of the vessels over the pelvic brim, and appear at the crural opening.

Again, evacuation may take place into the rectum, in which case, like its analogue—the abscess of tubal origin (pyosalpinx)—the fecal communication gives rise to constant reinfection and refilling of the abscess cavity when it empties itself into the intestinal canal. Finally, the bladder, and in the female the vagina, may serve as an outlet for the purulent collection.

CHAPTER IV.

Special Types of Appendicitis.

Special types or varieties of the disease are sometimes observed, differing from the affection as already described. Even in these cases, almost without exception, there can be obtained a history of the first, second and sometimes of the third stage of an average acute attack. From this point, however, the symptoms seem to veer off, as it were, from the typical course, only to return to it after a greater or lesser length of time.

The forms now to be considered are the subacute, the chronic, the relapsing and the recurrent varieties.

Subacute Appendicitis.—The *subacute* variety is not to be looked upon as an innocent form of the disease. Although the febrile action is slight, and the pain and tenderness such as occasion no alarm, these insidious symptoms may be replaced, without warning, by those indicating the occurrence of perforation, and suppurative or non-suppurative septic peritonitis; or the latter condition, as already stated in discussing the acute variety, may come on without perforation. The subacute form may supervene upon the acute variety. Convalescence may follow this remission of the symptoms, but the change from an acute to a subacute form is only too often more apparent than real, and leads to a sense of fancied security on the part of the physician and patient, to be followed by the occurrence of one or more of the grave accidents which only too frequently mark the further progress of the disease. This was strikingly exemplified in the case of Gambetta, the celebrated French statesman.

Chronic Relapsing Appendicitis.—Where the affection stops short at the first stage, or perhaps even recedes more or less from this to a stationary but persistent condition of subacute endoappendicitis, it is said to have assumed a chronic phase of the disease.

The mucous membrane, and perhaps in addition, the submucous connective tissue, persists in a condition of subacute inflammation, from which one or more relapses may occur in the course of a few weeks. The patient may become seemingly convalescent, in that pain and all febrile symptoms disappear. He may even be permitted to resume his avocation. Within a few weeks, or even earlier, a relapse takes place, with symptoms perhaps more violent and threatening than at first. There is one symptom, at least, which does not entirely disappear, and its presence should always place the attendant upon his guard against this form of the affection. I allude to the symptom of persistent tenderness. This is sometimes accompanied by the presence of a tumor, although the latter is not an essential symptom of this type of the disease.

Cases are sometimes observed in which the symptoms are, from the beginning, indicative of a subacute condition.

Recurrent Appendicitis.—This form of the disease is not rare. A certain proportion of cases occurring in adults will give a history of previous attacks, one or even more in each year. These cases are to be distinguished from the chronic relapsing form, and it has therefore seemed best to assign them to a special class. The special feature of the form under consideration is the fact that the attacks occur at either short or long intervals, suggesting some predisposing cause, which continues active after recovery from the first attack. It differs from the relapsing form of the disease in that entire recovery takes place. The patient remains free from any trace of the affection for varying periods, when suddenly and without warning he is subjected to another attack. The differences between the relapsing and the recurrent forms of the disease are analogous to the differences existing between an attack of typhoid fever in which a relapse and a second exacerbation supervenes during the convalescence, and an attack of malarial fever in which complete recovery takes place, but in which some predisposing condition existing in the patient, conjoined with some exciting cause incident to his surroundings, leads to a recurrence of the disease.

The length of time over which these recurrent attacks may

extend is surprising, as well as the remarkably large number which may occur within a short time, and yet recovery take place.

The following are presented as illustrative of this class of cases:

J. N., aged forty-five, was seen by me in consultation with Dr. Weygandt, of this city, during an acute attack of appendicitis. He declared that he had suffered during the past eight years from attacks of colicky pain, referred to the general abdominal region, occurring at intervals varying from one to three months, and that he must have had more than fifty such attacks. An operation performed January 12, 1893, revealed an appendix which was thickened, strictured, dilated beyond the stricture, ulcerated and perforated at the dilated portion, angulated at the proximal portion of the organ, and gangrenous between the angulated portion and the base. The appendix was removed.

The patient made a good recovery, and when last seen, nearly a year after the operation, he stated that he had remained in perfect health ever since that time.

Dr. H. W. C. came under my care with the following history: Two years before, while traveling in California, he was attacked during the night by appendicitis. He had eaten a hearty meal before retiring. After a week he convalesced. During the succeeding two years he suffered from thirteen separate and distinct attacks. These were sometimes preceded by diarrhœa, and sometimes by constipation. On October 27, 1891, the appendix was removed after the subsidence of an attack. It was found to be the seat of a chronic thickening, its cavity being obliterated, and its structure changed to that of a fibrous cord.

CHAPTER V.

Complications and Sequelæ of Appendicitis.

The most important complication of appendicitis is the occurrence of peritonitis in one of its forms. Inflammation of the serous investment of the appendix itself is not included in the present consideration, nor should the occurrence of this form of localized peritonitis, which leads to the formation of adhesions, be considered other than salutary. Diffused inflammatory affections of the peritoneum resulting from infection, or septic peritonitis, which may or may not result in a suppurative process, are, however, among the most frequent, as well as the most fatal, complications.

Iliac Phlebitis.—This may occur as a complication of appendicitis. The condition will prove a very obstinate one with which to deal. It is due to an infection, either from appendicular abscess, or a suppurative parietal appendicitis. In these cases the appendix lies in the direction E. or S. E. (Fig. 8). Phlebitis of both sides may occur simultaneously, due to an infection of both veins by a long appendix stretching across on the W. line; or the vein on the left side may become involved subsequently to that of the right.

Phlebitis with thrombosis of the iliac vein may give rise to edema of the corresponding lower extremity. If septic changes occur in the thrombus, and portions of the clot become loosened and displaced, pulmonary thrombosis and septic pneumonia may be among the sequelæ of appendicitis. The following case is offered for illustration:

J. K., aged eighteen, was admitted to my service, at St. Mary's Hospital, upon the recommendation of Dr. Pierson, suffering from the usual symptoms of acute appendicitis, of three days' duration. Seven years before (1886) he had suffered from a similar attack, which

eventuated in an iliac abscess. This was "lanced," as he expressed it. A scar, three-eighths of an inch long, marked the site of the former operation.

At the time of his admission iliac phlebitis and septic pneumonia were present.

An incision parallel with Poupart's ligament was employed. The peritoneum was found to be crowded away from the lateral pelvic wall. The peritoneum was not divided, but was pushed in a direction inward and upward. Upon exploring the space between the peritoneum and the lateral pelvic wall I came upon an abscess cavity containing about three ounces of pus. After the pus was removed the space was found to be bounded posteriorly by the iliac fascia. The appendix lay in the S. E. position, entirely extra-peritoneally, and rested directly upon the iliac vessels. It was removed.

The right-sided septic pneumonia, in progress before the operation, followed the usual erratic course of this disease, and recurring chills and exacerbations of fever occurred, coincident with fresh involvement of lung tissue. Final recovery ensued.

Where the complication of iliac phlebitis and thrombosis occurs the convalescence will be considerable prolonged. These cases are usually tedious, and are not amenable to any specific treatment.

Fatal Hemorrhage.—This may follow invasion of the iliac veins by the gangrenous process. The artery is much less liable to this accident. The following instance of the invasion of the right iliac vein came under my observation:

H. W., male, aged fifty-seven. Patient was seen by me January 22, 1891, in consultation with his family physician, Dr. Cruikshank. The usual symptoms of an acute appendicitis had accompanied the outset of the attack. Upon the fifth day he had apparently entered upon a safe convalescence, when grave symptoms suddenly supervened. An immediate laparotomy was performed. A gangrenous appendix was found in the S. E. position, imbedded in a mass of adhesions which were also in a gangrenous condition. The wound cavity was thoroughly cleansed and drained, after which the patient's condition improved. On the eighth day, while the wound was undergoing its usual daily redressing, a gush of blood followed the withdrawal of the gauze drains. This was temporarily controlled by the

finger passed to the bottom of the wound cavity, and a tampon, arranged as a graduated compress, was firmly placed in the cavity and controlled the hemorrhage. He never rallied from the loss of blood, however, and died upon the following day.

Complications arising through the Medium of the Portal Circulation.—When the freedom with which the mesenteric veins feed the portal circulation is taken into account, the ease with which septic emboli from thrombo-phlebitis of these radicles may be carried to the liver, and there give rise to hepatic abscess, will be readily understood. As a matter of fact, however, mesenteric thrombo-phlebitis is only an occasional complication of appendicitis. Reginald Fitz calls attention to the possibility of its occurrence, and suggests that it may be due, either to a direct extension of the primary phlebitis, or from septic embolism.[1] Three cases of hepatic abscess of appendicular origin, in which pleuritis and pericarditis followed an eruption of the abscess cavity through the diaphragm, are reported by Gendron.[2]

This, as well as other late complications and sequelæ of the disease, will become less and less frequent as the dangerous character of the disease becomes more generally recognized, and early operative procedures are instituted for its relief.

Hepatic Abscess—As a result of pylephlebitis, hepatic abscess, either single or multiple, may occur. This is a most serious complication, and may so mask the other symptoms as to completely mislead the attendant as to the true nature of the case. The thromboses within the mesenteric veins become displaced, either in their entirety, or by portions becoming loosened and swept by the current of blood into the portal vein, through which channel they reach the liver in the shape of sepsis-bearing emboli. The mechanism is the same as in hepatic abscess following dysenteric affections, and certain operative procedures upon the hemorrhoidal veins.

The symptoms of hepatic abscess following appendicitis are such as accompany suppurative foci within the liver substance

[1] American Jour. Med. Sciences, October, 1886, page 330.

[2] Étude sur le pylephlebite suppurative, Thésis de Paris, 1885.

due to other causes. Digestive disturbances, irregular chills, pain referred to the right hypochondriac region, erratic variations of temperature, tenderness just beneath the lower border of the ribs upon the right side, more rarely an icteric hue of the conjunctiva and skin, finally the occurrence of a tumor—these are the symptoms which change almost entirely the aspect of the case, and render the symptomatology puzzling to the medical attendant, unless he is mindful of the occurrence of this complication.

Purulent Pleuritis or Purulent Pericarditis.—These may result from the hepatic abscess. A large collection of pus, situated superiorly or posteriorly within the liver, will tend to find its way through the diaphragm. The latter will first be pushed upward, and give rise to difficulty of breathing. Later on the diaphragm itself will become inflamed, giving rise to considerable pain, and finally, ulceration and perforation will permit the pus to find its way into the pleural cavity, or into the cavity of the pericardium. If it be not removed from this situation by operation, and the patient survive sufficiently long, the purulent collection may ultimately be discharged externally either by means of a spontaneous opening between the ribs, or through the bronchi. Especial attention has been called to suppurative pleuritis as being a relatively frequent complication of appendicitis, by Terrillon.[1]

Pelvic Phlegmon.—An exceptionally long appendix, placed in the S. E. position, may lead to an infection of the tissues within the pelvis, the results of which may not be apparent until a considerable time has elapsed after the beginning of the disease, or after the operative procedure instituted for the removal of the diseased appendix. The following case is of exceptional interest in this connection.

M. E. S., female, aged twenty-one, was admitted to the Methodist Episcopal Hospital, May 14, 1893, suffering from a

[1] Discussion upon Quénu's paper, "Operative Treatment of Recurrent Appendicitis in the Intervals of the Attack." Bull. et Mem. de la Soc. de Chirurgie de Paris, Vol. XVIII, p. 397.

rapidlv developing attack of appendicitis. No previous attack had occurred. The abdomen was opened by the usual right-sided vertical incision, and the appendix, which was ulcerated and perforated, was removed. Its position was S. E., or directly downward and inward, across the vessels, and its length was five inches. The colon was placed abnormally low, and the appendix reached well down and into the pelvis and seemed to lie between the rectum and the uterus. The appendix was removed. The depths of the infected area were cleansed as thoroughly as possible, and a drain of iodoform gauze placed in position. The external abdominal wound was only partially closed. The patient was discharged from the hospital after a six weeks' convalescence with the wound entirely healed.

On October 2, 1893, nearly five months after the operation, she was again admitted to the hospital, with a history of having suffered from what was thought to be malarial fever. An examination disclosed a fluctuating tumor, situated between the uterus and the rectum, which filled the entire cul-de-sac of Douglas. A second laparotomy was performed. The tumor was found to be a large abscess, located behind the uterus. The rectum was nearly perforated by the abscess. Both tubes and ovaries were normal.

Lumbar Phlegmon.—This may have its origin in infectious processes, invading the post-peritoneal connective tissue. An antecedent history of appendicitis may usually be made out, culminating in the discharge of pus into the structures of the lumbar region. In two cases of this kind, occurring in my hospital service, one died from purulent infection of the lumbar and dorsal regions, and prolonged septic conditions. The autopsy revealed a small post-cecal abscess cavity, in the wall of which the thickened and infiltrated appendix lay. In the other case, upon incising the abscess wall, a large amount of pus, which had been walled in, escaped. Upon introducing the finger a communication was found to exist between this one and a similar smaller cavity lying behind the cecum.

There is a growing belief among surgeons that the dorso-lumbar abscesses of former times which could not be ascribed to a lesion of the osseous spinal column, and which were sometimes called peri-nephritic abscesses for want of a better notion regarding their origin, were really cases of suppurative inflammation of

the retro-peritoneal connective tissue, having their origin in an appendicular abscess, in instances in which the appendix lay entirely or in part behind the peritoneum. Even a history of an acute attack of appendicitis may be absent in these cases, and yet the infection have its origin in the appendix.

Parietal Phlegmon.—Abscess of the anterior abdominal wall is comparatively rare. A case of this kind came under my notice at St. Mary's Hospital. The history dated back several weeks, and involved the usual and typical symptoms of appendicitis. Two other cases were seen in consultation. The patients were both children. The primary attack in the one case occurred two months, and in the other case three months previously. The abscess in both cases pointed at the umbilicus.

The Occurrence of Appendicitis in a Hernial Sac.—This should be noted as among the complications occasionally met with. At a meeting of the Brooklyn Surgical Society,[1] Dr. Rand presented a case in which an old and irreducible femoral hernia became the seat of a phlegmonous inflammation. The usual symptoms of appendicitis preceded the local appearances. An incision revealed the existence of an inflamed appendix, with an encysted sero-purulent collection.

Fecal or Urinary Communication.—These conditions resulting from a spontaneous evacuation of a purulent or sero-purulent collection into the rectum or bladder, giving rise to renewed infection from these sources, have been already referred to as a complication.

Appendicitis Complicating Pregnancy.—This complication is of occasional occurrence. Four instances have come under my observation in a series of 150 cases. All four developed septic peritonitis before coming under observation. In two, abortion took place prior to operation, while in the others the uterus emptied itself after the operation. All four died, the abortions not necessarily hastening, but rather heralding the fatal issue.

Talamon[2] mentions a case observed by Oppenheimer, in which the patient, at the seventh month of pregnancy, was

[1] March 16, 1893.

[2] Op. cit.

attacked with the usual symptoms of appendicitis. Premature delivery took place on the third day, resulting in death. At the autopsy a post-cecal para-appendicitis, and a perforated appendix were found, with pus burrowing along the kidney, and into the post-peritoneal connective tissue. Metastatic abscesses in both liver and spleen were likewise observed.

Appendicitis Complicating the Puerperal State.—One case of this kind was sent to my hospital service by Dr. F. E. Wilson, of this city. The case recovered after laparotomy. In all probability there was no especial relation existing between either the parturient act or the puerperal state and the etiology of the disease, inasmuch as the attack occurred ten days after the delivery. Attention is called to the case from the fact that when appendicitis occurs in the pregnant condition, as far as my experience goes, it is invariably followed by abortion with a fatal result; but in the post-parturient condition at term it does not seem to be such a mortal affection.

Appendicitis Complicated by Intestinal Obstruction.—Appendicitis may be complicated by intestinal obstruction, either through the formation of viscous adhesions or by the appendix itself, acting as a constricting band. (See page 121.) The latter may readily occur when the appendix is placed in the position shown at C, Fig. 9.

CHAPTER VI.

The Etiology of Appendicitis.

The etiology of inflammatory suppurative conditions in the neighborhood of the right iliac fossa was supposed in former times to involve the presence within the appendix vermiformis, of cherry-stones, grape-seeds, lemon- and orange-pits, date-stones fish-bones, pins, etc. This idea was so firmly fixed in both lay and professional minds that children were carefully watched while eating fruit to prevent them from swallowing a stone or seed, which, it was believed, would lodge in this "death trap," as it was popularly called, and produce what was at that time considered an almost necessarily fatal malady.

This belief seems to have been based upon evidence which is deemed insufficient by scientific men of the present day, although it is not to be denied that traumatic appendicitis may occur. The following instance reported by M. Mustivier, as far back as 1759, the account of which is borrowed from Talamon, may have served, like the pathology of the disease as set forth by Albers, as a basis for the writings of subsequent authorities:

A man, forty-five years old, was admitted to the Hospital St. André de Bordeaux, suffering from a fluctuating tumor in the umbilical region to the right of the median line. The tumor upon being opened discharged a pint of pus. A fatal termination took place, and at the autopsy a pin was found, encrusted with earthy matter, which had served as the starting point of the disease by perforating the appendix vermiformis ceci.

There can be no question in this instance of the origin of the condition; but this case was not one of appendicitis, as we now view it. A similar condition might have followed the passage of the pin through any portion of the intestinal wall. Even the presence of the "earthy matter" need not necessarily have prevented the point of the pin from perforating the walls of the appendix.

The belief that the disease is frequently due to the engagement of foreign bodies in the cavity of the organ, is based to a large extent upon purely speculative or imaginary conditions, or erroneous observations. In an exceptionally large experience in the operative treatment of this disease, in but two instances was any body found other than soft fecal masses, which could be construed as being in any sense "foreign." One of these two was a true enterolith, oval in shape, and made up of calcareous salts, arranged in concentric layers (Fig. 10); the other was a gall-stone. The exceptionally rare character of the foreign body in this latter instance, will perhaps warrant a detailed account of the case. It is further interesting from the fact that it approaches nearer than any case with which I have been brought in contact, to the cases of so-called appendicular colic that Talamon has

FIG. 10.

described; these he employs as a basis upon which to build up the theory that "hardened fecal matter forced into the musculo-membranous tube" is a prominent cause of appendicitis.

The patient, an upholsterer by trade, was brought into St. Mary's Hospital on August 15, 1891, with the following history: On July 8, while hanging shades, he swallowed a small nail, such as is used for fastening the shade to the roller. Upon the same day he suffered from an attack of sharp pain in the right hypochondriac and epigastric regions, which required full doses of opium to allay. This was thought by his medical attendant to be in some manner connected with the presence of the nail. This attack subsided, and ten days later another accession of violent abdominal pain occurred, which finally settled in the right iliac fossa. Upon his admission a tumor was found in the right iliac fossa. A laparotomy revealed an abscess cavity, containing six ounces of pus, during

the evacuation of which a gall-stone, the size of the tip of the little finger escaped. Further exploration revealed the fact that an appendicitis existed, the cause of which was evidently an attempt on the part of the gall-stone to enter the cavity of the appendix. This was shown by the sloughing away of the appendix from the cecum at the point of its attachment. A ragged hole in the cecum, with gangrenous margins, occupied the site of the base of the appendix, which could be felt as a hard, rounded, elongated, rope-like body, lying in a mass of adhesions in the S. E. position.

In this case it is evident that the gall-stone was the cause of the appendicitis. It had lodged directly at the appendicular orifice. Its roughened exterior had probably produced an abrasion of the epithelial lining of the cecum, and necrosis of the mucous membrane had taken place. This in turn was followed by an infection of the sub-mucosa. The occurrence of gangrene, causing the separation of the appendix from the cæcum, may be explained either by the persistent pressure of the gall-stone or by the accidental occurrence of thrombo-stasis, due to occlusion of the nutrient artery. The presence or absence of a mesentery for the appendix could not be ascertained.

In all probability the notion that cherry-stones, lemon- and orange-pits or date-stones are largely responsible for the occurrence of the disease is based upon the fact that little masses of fæcal matter, which have been moulded into shapes accurately representing these bodies are found during the evacuation and irrigation of an appendicular abscess. It has happened more than once during an operation of this character at my hospital clinic that one or another of the bystanders has exclaimed, as the little mass of fecal matter came into view, "a lemon-pit!" or "a date-stone!" so strong a resemblance was there between these masses and the bodies mentioned. In every instance, however, the fact that they were, with the above-mentioned exceptions, made up of moulded fecal matter was demonstrated by simply flattening them out between the thumb and finger.[1]

[1] The possibility of the production of the disease by foreign bodies is not denied; the statement is simply made that, as a clinical fact, in my experience, it is of rare occurrence.

Beyond the little masses of fecal matter which become imprisoned in the cavity of the appendix by the occurrence of constriction, either at the point of communication with the cecum or at some other portion of the tube, nothing in the shape of a foreign body, other than those above-mentioned, has been found in my experience to account for the conditions present. The ease with which fecal matter may maintain its position in the cavity of the appendix may be easily understood when two facts in the anatomy of the organ are borne in mind. These are, first, the fact that it normally occupies a dependent position in the large majority of cases; hence, gravity alone will aid the passage of fecal matter into its interior, and also favor its retention there. Second, the absence of well-marked circular muscular fibres gives rise necessarily to a very feeble expulsive power. Hence, it may be said that the appendix vermiformis does not have that inherent power of emptying itself which other hollow organs, supplied with longitudinal and circular involuntary muscular fibres, combined in proper proportions, possess. In addition, anatomical studies and clinical experience (examinations made of healthy appendices during laparotomies) unite to support the assertion that fecal matter is found in a considerable number of appendices in individuals who had never suffered from the symptoms of appendicitis. The mere presence of masses of fecal matter, therefore, cannot be looked upon as necessarily producing the disease, even though these become more or less hardened by inspissation. This hardening process takes place after their imprisonment, and is due to absorption of the watery elements after the escape of the fecal matter itself is cut off. In this condition they may, by their presence, produce in an already inflamed and partially devitalized organ, ulcerative changes, or even extensive gangrene, by still further interfering with the normal circulation. That they do not necessarily give rise to the disastrous perforation which is so frequently a marked feature of the disease is shown by the fact that they are not always present when this accident occurs. When they are present they are rarely found at the point of ulceration, but are located, in the great majority of cases, either above or below the

site of the perforation. Moreover, cases are observed in which the entire outer structure of the appendix has sloughed away as a result of a violent inflammatory process, leaving the mucous membrane as an intact blind sac with fecal matter in its interior. The following case, occurring in my hospital service, will illustrate this condition:

H. T., aged eighteen, male, was admitted to the Methodist Episcopal Hospital with the history of having been attacked seven days previously with the usual symptoms of appendicitis. General peritonitis was present and the patient's condition was very unpromising. The usual right-sided laparotomy revealed the remains of the appendix in the shape of a worm-like tube, consisting exclusively of the mucous lining of the organ. This was not perforated, although at a point midway between its tip and the place of its attachment to the large intestine its lumen was occupied by a rather hard fecal concretion (Fig. 11). The walls of the organ had sloughed completely away. The cavity of the peritoneum contained a large amount of sero-purulent material.

FIG. 11.—(× ⅔). The intact mucous lining of an appendix, the outer walls having sloughed away, showing a coprolith in position (from a photograph).

How much the presence of fecal matter, independent of its mechanical effects, may influence the origin of the inflammation is yet to be determined. The fact that fecal matter of itself does not necessarily give rise to the disease is, to my mind, sufficiently proven.

In all probability it will be found that the inflammation has its origin in noxious agents (micro-organisms) which are conveyed to the interior of the organ in the fecal matter when the latter is present. Although these agents are usually present in fecal matter, they may find their way into the tube without the aid of the latter.

As predisposing causes to the disease may be mentioned actinomyces and tubercular and typhoid ulcers. The influence of fecal concretions has already been referred to. Actinomycotic

appendicitis has been observed by Ransom[1] and by Otto Lanz.[2] The occurrence of occlusions of the lumen, either partial or complete, are likewise predisposing factors. These occlusions may be the result of former inflammatory changes, but are more frequently the result of retrograde evolution which this organ seems to be gradually undergoing.

The invasion of the mucous membrane, and of the submucous layer of connective tissue as well, by micro-organisms which are possibly harmless so far as the mucous membrane of the colon is concerned, but are disease-produciug in the mucous membrane of the appendix, at all events, will account for all of the phenomena of the disease. The normal epithelial lining of an organ, useless in the animal economy, and which is probably undergoing evolutionary changes tending towards its final disappearance, may be found by the histologist to have already been subjected to changes which distinguish it from that lining the cecum, and which may have robbed it of its function as a barrier to bacterial infection. Among these evolutionary changes a progressively lowered vital resistance would naturally be the first departure, so far as the tissues are concerned, and this alone would favor violent inflammatory alterations, though the same etiological factors would not be sufficient to produce these effects in the colon or ileo-cecal region. It has been suggested that the difference in the lumen of the cecum and appendix may account, to some extent, for the immunity of the cecum and the susceptibility of the appendix. It is easier to produce abrasions in a small tube than in a large one, and the mucosa once deprived of its epithelium easily becomes infected by micro-organisms.

The conclusion is, therefore, irresistible that infection is not only the principal and necessary cause of appendicitis, but that it is also the primary cause.[3] Some infectious material enters the appendix, and there becomes fixed as a result of the very inefficient expulsive power of the organ. The secretions of the appendix furnish excellent soil for the development of the

[1] Proceedings of the Royal Med. Chir. Soc., London, 1891–2, S. IV, 14.

[2] Korrespondenzblatt für Schweizer Aerzte, 1892, No. 19.

[3] The *immediate* primary cause is here meant. For predisposing causes, see chapter on Pathological Anatomy.

micro-organisms. The degree of virulence of these organisms will govern the violence of the inflammatory catarrhal attack if other conditions, such as the existence of stenosis of the canal, or the presence of concretions, are favorable. The ease with which the disease may become chronic is due to the fact that the tissues of the organ are being continuously fed by constantly proliferating infectious material and its toxic products. With any increase of virulence there occurs a renewed or acute attack. Whatever fecal matter, either fluid or solid, chances to be present plays but an accidental rôle. It is not even necessary that these fecal masses should produce either ulceration or even abrasion of the mucous membrane. As a matter of fact, their physical qualities are usually such as render it altogether probable that they produce no primary lesion, but that in their soft condition they may remain for an indefinite period of time within the tube without doing harm. That fecal masses do occur within the cavity of the appendix vermiformis without the occurrence of inflammatory processes is proven by the frequency with which their presence is noted in post-mortem examinations, as well as in laparotomies performed for other conditions.

The relation of the blood supply to the occurrence of the disease has led to a critical study and review of the conditions which govern this supply. These studies have been principally directed to the presence or absence of a mesentery connected with the organ. So far as I have been able to judge, from the examinations made of appendices removed in a diseased condition, the disease occurs quite as often in those individuals in whom a well-formed and vascular meso-appendix is present as in those in whom the mesenteric attachment is but slightly developed or altogether absent.

The study of the clinical anatomy has not, to my knowledge, been heretofore undertaken. The shape and relative position of the appendix as found in individual cases may favor the development of the disease. Thus, an angulated or exaggerated curve-shaped appendix may favor circulatory disturbances,[1] and a directly vertical position with the tip downwards the

[1] See page 76.

engagement in the orifice of hardened fecal matter, which, acting as a local irritant, leads to the development of the disease. The absence of anything like uniformity in its relation and direction under conditions of both health and disease,[1] however, makes it improbable that the above-mentioned conditions are etiological factors except in a casual or predisposing manner. While, therefore, these will explain the occurrence of certain symptoms in some cases which are absent in others, they cannot be looked upon as essentially etiological factors in the disease.

The condition of the bowels prior to the attack has been the subject of considerable study in connection with the disease. The only conclusion which can be drawn is that neither preceding constipation nor diarrhœa occurs in a sufficiently large number of cases to stand in a causative relation to the disease; and that a normal condition of a daily movement of the bowels is observed in the majority of cases.

The influence of age upon the occurrence of the disease is of importance. The affection is not confined, by any means, to the age of childhood as was formally supposed; yet its somewhat greater relative frequency in early life has led to the opinion that age is one of the predisposing causes. It is rare at the two extremes of life. The comparative frequency, in my experience, of the disease at the different periods of life, agrees essentially with the observations of Bamberger, Paulier and Maurin, as given by Talamon, and of Reginald Fitz, to whom the profession is greatly indebted for a large number of accurate observations upon the disease.

The influence of sex upon the occurrence of the disease has been studied by Bamberger (1864), Volz, Marchal, Paulier (1875), Fitz (1886 and 1888), and Maurin (1891). Taking the total number of cases of these observers, and combining them, the following result is obtained:

Total number of cases observed	543
Total number occurring in males	430
Total number occurring in females	113
Percentage occurring in males	80
Percentage occurring in females	20

[1] See ANNALS OF SURGERY, May, 1894, p. 562.

In my own experience, about the same proportion of males to females was observed.[1]

Among the occasional causes laid down by writers, traumatism is mentioned. In my experience, not a single instance occurred in which a kick or a blow upon the abdomen or a fall constituted a portion of the history. The nearest approach to injury is the case of an ice-man, who attributed the attack to a strain he had received the day before in lifting a heavy block of ice from his wagon.[2] Another instance is that of an athlete in whom the disease developed during the night after he had engaged in a game of football. In neither of these cases does it seem to me that the violent effort or exercise bore any causative relation to the attack of appendicitis.

Indigestion has also been regarded as one of the determining causes of the attack. This belief has probably arisen from the frequency with which vomiting and pain, referable to the epigastrium, are prominent symptoms of the first stage of the attack. These symptoms, as has already been insisted upon, are not due to digestive disturbances, as a rule, but are purely reflex phenomena. It rarely happens that undigested food is vomited, and the movements of the bowels following upon an attack of appendicitis do not show evidences of irritating ingesta. It is common enough to have patients declare that they must have eaten something which disagreed with them, but so far as my experience goes I have failed to trace an etiological relation to such a cause even by careful questioning, save in but a single instance (*vide infra*). Talamon, however, believes that the erratic peristalsis produced by the presence of irritating material alone within the digestive tract determines the engagement of a stercoral calculus in the orifice of the appendix. This in its turn gives rise, according to this observer, to the symptoms here described as constituting the first stage of the disease.

In the rare instances in which the digestive disturbance seems to precede the development of the disease, the connection between the two occurrences may still be dependent upon bacte-

[1] *Op. cit.*, p. 546.

[2] See page 127.

rial agency. It has been shown by experiments upon animals that cultures of the intestinal micro-organisms derived from patients, the subjects of diarrhœal diseases, possess far more virulent toxic properties than those taken from healthy individuals.[1] Whether the catarrhal inflammatory conditions present in these diseases, and which, to a greater or lesser extent, are present in those attacks commonly regarded as the result of indigestion, and the increased virulence is due to the irritating ingesta which produced the indigestion, or whether, in the life-history of the bacterium, the virulence occurs as a part of the biological changes which it undergoes, this, in its turn, acting as the irritating or infectious agent, has not as yet been determined. If the former it may readily be supposed that an attack of indigestion, by producing certain changes in the intestinal tract and converting the theretofore harmless micro-organism into one of greater or lesser virulence, would stand in a causative relation to the disease. In this connection the following case is of interest:

M. B., aged forty-seven, with no history of a previous attack, and of previous regular habit of bowels, dined at a cheap restaurant, which was not at all his habit, making a hearty meal of pork and cabbage. He was attacked the same evening (December 15, 1889) by pains, referred to the epigastrium, and with vomiting. Pain in the right iliac region developed four hours later and tenderness in the latter region was present upon the following day. The vomited material consisted of the partially digested food of the above mentioned meal. I saw him on the fifth day, at which time a tumor was present. An incision made into the latter, evacuated about five ounces of sero-purulent material from a cavity formed by adhesions about the inflamed appendix. The latter lay in the N. E. position, and was evidently a portion of the limiting wall of the abscess cavity in that direction. For this reason the organ was not removed.

The patient made a good recovery, but on November 19, 1892, nearly three years later, he dined, under the same circumstances, at the same restaurant, and partook of the same character of meal. The same evening he was attacked with pains and vomiting; the pain finally centered in the right iliac fossa. The vomited material showed

[1] Macaigne, Le Bacterium Coli Commune, Paris, 1892.

partially digested pork and cabbage. Within thirty-six hours of the commencement of this attack primary perforation and septic peritonitis had taken place, shortly after which I saw him and operated. The appendix was removed and it was found to have been the seat of a rapidly suppurative process; extreme dilatation had taken place and rupture of its contents into the general peritoneal cavity followed. The patient was a diabetic, with low powers of vital resistance. It is interesting to note that the appendix, at the second operation, lay in the S. E. position.

In spite of the fact that the terms "typhlitis" and "perityphlitis" have been virtually abandoned, for the reason that, whatever the origin of the inflammation, the involvement of the appendix contributes most largely to the dangerous character of the affection, it is still thought by careful observers that the disease not infrequently has its starting point in a catarrhal inflammation of that portion of the cecum corresponding to the point of communication between the latter and the appendix. Kümmel[1] still insists that the chronic relapsing form of appendicitis has it origin in inflammatory catarrhal processes within the cavity of the cecum, being propagated thence by continuity of tissue to the interior of the appendix. The secretion of the latter continues to empty into the colon until the point of communication is closed by swelling near the orifice, or by stenosis elsewhere. This view is also held by Iversen, and is supported by the frequency with which strictures of the vermiform process are observed in the relapsing form of the disease. In this variety, too, perforation is the exception, and not the rule. While a mild inflammatory process at this part of the cecum may pass away without the occurrence of symptoms sufficient to call attention to its presence, the occurrence of even a slight catarrhal inflammation of the appendix leads to constriction of the tube, the retention of secretion and to the formation of coproliths.

To sum up, therefore, the disease may be due: first, to infection from the presence of one or more of the intestinal micro-organisms; second, to circulatory disturbances, more or less readily produced by sharply curved or angular shapes of

[1] Archiv. für klinische Chirurgie, Vol. LIII, 3 and 4.

the organ, or a deficient blood supply; third, to the presence of accidentally imprisoned fecal matter, which is prevented from returning to the cecum both because of the feeble expulsive power of the tube, due to an insufficiency or entire absence of circular muscular fibres, and on account of constriction of the tube which may or may not be due to previously existing inflammation. This fecal matter, because of bacterial infection which it conveys to the parts, or from the pressure effects due to inspissation, or both, contributes to the etiology of the disease in its entirety, but particularly in the cases in which perforation takes place. Bacterial infection, however, may occur independently of the presence of fecal matter, and the presence of fecal concretions is not at all essential to ulceration, perforation or gangrene.

As predisposing causes of the disease are to be mentioned, certain disturbances of nutrition, involving either vascular or nervous lesions, or both, which, by lowering the local vital resistance of the tissues of the appendix, prepare the way for bacterial infection. For an account of the changes resulting from these disturbances, see the chapter on Pathological Anatomy.

CHAPTER VII.

Bacteriological Considerations.

The question of the relation existing between the bacteria of the intestinal canal and the etiology of appendicitis has recently awakened an unusual interest among both bacteriologists and surgeons, owing to a more careful study of these micro-organisms. From the time when the digestive tube becomes the receptacle of food and its products, these bacteria are found in greater or lesser variety.

Attention has been particularly called to the ordinary and common form of bacillus which is found in the discharges from the intestinal canal so constantly that the latter has come to be looked upon as its natural habitat. This organism, known as the *bacillus coli communis* (Escherich), it would appear, bears a more or less definite relation not only to inflammatory conditions within the abdominal and pelvic cavities, but likewise to these conditions when occurring under certain circumstances remote from the intestinal tract. For instance, it may, according to a number of observers, pass the barrier of the intestinal mucosa, although under favorable conditions it is claimed that it may even give rise to active desquamative lesions here, and penetrate into the general circulation; thus, reaching parts remote from its original and apparently normal location, in which it seems to play an innocent rôle, it has been claimed to give rise to suppurative conditions of the most decided character.

While the fact of its discovery in pure culture, in cases of enlarged spleen (Wyss), in a hematoma following thyroidectomy (Tavel), in diseases of the biliary passages (Gilbert, Girode, Naunyn), in abscess of the liver (Rodet, Veillon, Jayle, Stern, and A. Fränkel), in lymphangitis of the arm (Levy), in septic emphysema (Chiari), in general pyemic infection, with suppurative meningitis (Stern), and in broncho-pneumonia, endocarditis,

meningitis, nephritis, and cystitis (Henkemaus), is of interest, yet its presence in connection with these conditions does not possess an importance beyond the fact that it serves to establish its migratory character in connection with our present study. Its presence in connection with suppurative peritonitis (Larulle, Roux, Rodet, and A. Fränkel) and in peritonitis consecutive to an intestinal lesion without perforation (Welch), and in cases of appendicitis, both acute, perforative, and chronic relapsing (Ekehorn, Roswell Park, Hodenpyl), together with my own heretofore published observations upon this subject,[1] seem, at first glance, to establish a direct and specific etiological relation between the *bacillus coli communis* and inflammatory diseases of the appendix vermiformis.

In addition to demonstrating the existence of this micro-organism in the exudate of the accompanying peritonitis of appendicitis, it has been shown (Hodenpyl) that the cavity of the appendix in new-born children, as well as the healthy peritoneal cavity in general, is sterile. Again, in so far as experimental bacteriology can establish the fact, the *bacillus coli communis* has been demonstrated to be pathogenic to rabbits and guinea-pigs, when bouillon cultures made from isolated colonies, obtained from appendicitis cases, are injected into the abdominal cavities of these animals (Ekehorn, Hodenpyl, Wilson). The suggestion of Ekehorn,[2] however, that, in comparatively mild forms of the disease (recurrent and relapsing cases), the virulency of the bacillus is not so great, as shown by its effects upon the lower animals following inoculation with cultures derived from acute and rapidly-progressive instances of the disease, is not borne out by experiments made for me by Dr. Wilson, at the Hoagland Laboratory.

The fact that the *bacillus coli communis* can be obtained in pure culture from the peritoneal surface of an inflamed appendix which has not undergone perforation, as well as from the walls of the organ, the interior of its mucous canal, from the contents of an appendicular abscess, and both isolated and non-encysted intra-

[1] The New York Medical Journal, Vol. LVIII, October 14, 1893, page 434.

[2] Bacterium Coli Commune, en orsak till Appendicit, Upsula Läkere. Förh., 1892–3, XVIII, 113–150.

peritoneal collections of fluid which have undergone changes the result of septic influences, is now well established. It has, likewise, been conclusively shown (Hodenpyl) that this micro-organism exists under normal conditions in the cavity of the vermiform appendix.

In one of my cases of appendicitis a pure culture of the *bacillus coli communis* was obtained from a layer of plastic lymph which glued the inflamed appendix to the cecum. The mucous membrane of the organ was not involved in the inflammation, and, although the walls of the organ were involved in an exudative inflammatory process, a large number of sections made by Professor Van Cott failed to reveal the presence of the micro-organism. It will probably be found that decided disturbances of the relations of the intestinal canal, such, for instance, as the fixing of the colon in an abdominal wound for the purpose of an artificial anus, will lead to the migration of the intestinal micro-organisms. Dr. Bristow reports to me that in a case of this kind, occurring in his service at the Kings County Hospital, a pure culture of the *bacillus coli communis* was obtained from the exudate which formed between the serous surface of the colon and the parietal peritoneum. No sutures were employed in the case, the colon being simply lifted into the abdominal wound and there supported upon a glass rod. The cultures were taken on the third day following the first stage of the operation, and prior to the opening of the gut.

The assumption, however, that the *bacillus coli communis* is the sole infecting agent of appendicitis and perforative peritonitis is apparently unwarranted, according to Barbacci, of Florence.[1] This observer examined 14 cases of perforative peritonitis in man, and made a number of experiments upon animals. Of the 14 cases, 1 was an aspirated so-called perityphlitic abscess; 7 were typhoid perforations; 2 were perforating ulcers of the stomach; 1 of perforation of the vermiform appendix; 1 of perforation from strangulated hernia; 1 of perforating ulcer of the cecum; and 1 of gangrene and perforation following volvulus. Bacterio-

[1] Ueber Aetiologie und pathogenese der Peritonitis durch Perforation. Centralblatt f. Allgemeine Pathologie u. Pathologische Anatomie, October, 1893.

logical examinations were made under favorable conditions,—*i.e.*, immediate autopsies in cold weather, to exclude putrefactive organisms.

Barbacci reaches the following conclusions :

(1) In perforative peritonitis in man, cultures from the exudate yield only one organism in the vast majority of cases,—the *bacillus coli communis*. In but a single case of the fourteen was another micro-organism, the *micrococcus lanceolatus* (Fränkel), associated with the *bacillus coli communis*. (2) Inoculations into the peritoneal cavity of susceptible animals (white mice and guinea-pigs) with fresh exudate of peritonitis produce peritonitis, and in eight cases out of the thirteen the *micrococcus lanceolatus* was found. (3) The *micrococcus lanceolatus* is present in about 60 per cent. of all cases, but is overlooked because it is overgrown by the *bacillus coli communis*. (4) Experiments on dogs by opening the abdomen, securing a loop of intestine, and causing a perforation by the application of caustic potash produced a peritonitis exactly simulating, both microscopically and bacteriologically, a perforative peritonitis in man. The animals died in from twenty to thirty hours, and examination after death show a general fibrinous peritonitis. Enteritis was not found in any of the cases. Pure cultures of the *bacillus coli communis* were obtained from the exudate. (5) Marked differences exist as to the result when, upon the one hand, the examination is made directly from the exudate, or by the culture method, on the other. Cultures show only *bacillus coli communis*, but by direct examination a number of different organisms may be found, the latter dying in the exudate in the early stages of the inflammation, the *bacillus coli communis* growing alone in the cultures. In dogs killed at intervals of 5, 5½, 6, 8 and 10 hours after perforation, examination showed the *bacillus coli communis* mixed with other organisms up to eight hours; after this the former alone was found. The *micrococcus lanceolatus* was not found in the experimental peritonitis in dogs.

Dr. Ezra H. Wilson, pathologist to St. Mary's Hospital, director of the Department of Bacteriology of the Hoagland Laboratory, and chief of the Bacteriological Bureau of the Brooklyn Board of Health, at my request made bacteriological examinations in the following cases of appendicitis occurring in my hospital services. The operations for the removal of

the appendix were conducted aseptically,—*i.e.*, only heat-sterilized instruments, etc., were employed; no antiseptic agents were employed in the case until after the removal of the organ. In each case the latter was ligated at two points, and the section for its removal made between two heat-sterilized ligatures. The appendix was then placed in a sterilized glass tube, which was immediately sealed and forwarded to the laboratory for examination. In two cases (Nos. 7 and 8) smear preparations for direct examinations, and direct cultures were also made.

The technique of the examinations was as follows: The cultures were made in peptone bouillon from the mucous membrane through sterilized incisions in the wall of the appendix. Cultures were also made from the outside of the appendix, and also from the exudate of the peritoneal cavity in some cases, at the time of the operation. Smear preparations were made directly from the exudate; these were stained and examined immediately.

Bouillon cultures were incubated for twenty-four hours and then plated. From the isolated colonies of the plated preparations other bouillon cultures were made, which were used for experiments upon animals.

The media employed were beef-peptone bouillon and gelatin.

Case I.—November 7, 1893. Male, twenty-seven. No previous attacks. Was attacked suddenly with acute abdominal pain. Tumor developed rapidly, and was distinctly felt at the end of twenty-nine hours. Operation thirty-two hours after commencement of symptoms. Appendix surrounded by a mass of adhesions, and the seat of a cystic dilatation. No other adhesions. Appendix amputated between two ligatures and placed in a sterilized glass tube for examination. Recovery.

Bacteriological Examination.—Appendix surrounded by considerable new tissue and fibrin. Two cavities were present, separated by a constriction.

The lower cavity contained pus. Cultures were made from both cavities and from the outside of the appendix, and carried along parallel. The cultures from both developed pure *bacillus coli communis*. From 1 to 2 c.c. of bouillon cultures derived from isolated colonies were injected into the peritoneal cavities of guinea-pigs. The animals

died in from twenty-four to forty-eight hours, and the organism was recovered in pure culture from the peritoneal cavity. It was not found in or recovered from the blood or organs. The peritoneal infection was very slight; the animals apparently died from general sepsis.

Case II.—November 25, 1893. Male, fourteen. No previous attack. Suddenly attacked with usual symptoms; local tenderness developed within two hours. Fever pronounced from the commencement. No tumor. Operation on second day of disease. Appendix divided between two ligatures and removed. No perforation. Placed in sterilized tube as in Case I.

Bacteriological Examination. —Same technique as in No. I. Result; Pure cultures of *bacillus coli communis* obtained in all of the cultures. Pathogenic to guinea-pigs.

Case III.—November 26, 1893. Male, twenty-eight. Two previous attacks; the first two years, and the second one year, ago. Present attack sudden in onset, with general abdominal pain. Temperature ranged from 101° to 102° F. No tumor. Great prostration and anxious facial expression from the second day. Admitted to hospital on the fifth day, and operated upon at once. Sero-purulent fluid in the peritoneal cavity. Appendix removed and cared for as in other cases. Appendix gangrenous, perforated in two places. Three small fecal masses present. Patient died of profound septic intoxication and pre-existing peritonitis in thirty-six hours.

Bacteriological Examination.—Technique same as in Nos. I and II. In the Petri dish, colonies of a different nature were found. These proved to be the *bacillus pyogenes fetidis.* The colonies of *bacillus coli communis* were scanty, while those of the *bacillus pyogenes fetidis* were very abundant.

The *bacillus coli communis* was pathogenic for guinea-pigs, causing death in forty-eight hours. The death resulted from peritonitis and toxemia combined.

The *bacillus pyogenes fetidis* proved to be exceedingly virulent. It was pathogenic for guinea-pigs when used in the same manner as the *bacillus coli communis*, causing death of the animal in twelve hours.

Bouillon cultures derived from isolated colonies of the *bacillus pyogenes fetidis* were filtered through sterilized Chamberland filters, and proved to be sterile by culture. Two cubic centimeters of this sterilized culture were injected into the abdominal cavity of guinea-pigs with a negative result. The animals recovered in each instance.

Case IV.—November 28, 1893. Male, twenty-two. Chronic relapsing appendicitis operated upon one week following a relapse. First attack five months previously; has suffered one attack each month on an average since. No tumor. Appendix thickened, surrounded by adhesions, and hanging from its implantation in the cecum in the shape of an inverted interrogation point.

Bacteriological Examination.—Cultures made from the outside of the appendix and from adhesions. Both developed pure *bacillus coli communis.* Bouillon cultures twenty-four hours old made from isolated colonies were injected into the peritoneal cavity of guinea-pigs. These caused death in thirty hours. The organism was recovered pure from the peritoneal exudate, but not from the blood or organs.

Case V.—December 7, 1893. Male, ten. Chronic relapsing appendicitis operated upon one month following the fourth relapse. Patient also the subject of acromegalia. No tumor. Typical amputation of the appendix, which was four and a half inches long, corkscrew-shaped, placed in the directly downward (S) position, and notably thickened.

Bacteriological Examination.—Cultures from the appendix and its cavity developed pure *bacillus coli communis.* Pathogenesis not tested.

Case VI.—December 11, 1893. Male, twenty-four. One previous attack eight years ago, which led to the formation of abscess. This was incised. No attempt was made to remove the appendix at that time. Present attack sudden in its onset, and accompanied by the usual symptoms of an average severe attack. Chill occurred on the third day. Pneumonia developed and present at the time of the operation. Tumor present. Lumbar tenderness. Operation between the fourth and fifth day. Appendix found to be entirely extraperitoneal. Removed. The patient made a good recovery in spite of the presence of pneumonia at the time of the operation.

Bacteriological Examination.—A mixed growth developed, consisting of a micrococcus and a bacillus. The latter was rather larger than the *bacillus coli communis*, and stained very slowly. The micrococcus was somewhat larger than the *staphylococcus pyogenes aureus*, and stained readily. Placed in Petri dishes and isolated, the micrococcus proved to be the *micrococcus flavus liquifaciens*, and was evidently a contamination. The bacillus proved to be *bacillus coli communis.*

Case VII.—December 15, 1893. Male, twenty-three. Four

previous attacks at intervals of about a year. Present attack came on gradually for first twenty-four hours. It then suddenly developed into an acute condition, following which septic symptoms and great prostration rapidly supervened. Abdominal cavity, upon being opened, revealed some clear fluid. Some of this was obtained in sterilized Sternberg bulbs. A large sero-purulent collection surrounded the appendix. Smear preparations were made on clean slides directly from the exudate. Cultures upon agar plates were also made directly from the exudate. Appendix removed and placed in a sterilized glass tube. Patient died in thirty-six hours from profound sepsis.

Bacteriological Examination.—The smear preparations show a variety of organisms. Small diplococci resembling the *diplococcus lanceolatus*, small and large bacilli, some of which resembled *bacillus coli communis*, and a streptococcus resembling the *streptococcus pyogenes* were present. Single colonies from one agar plate, at room temperature for twenty-four hours, show pure *bacillus coli communis*. The other agar plate, placed for the same length of time at incubating temperature, showed likewise only *bacillus coli communis*. The serum drawn from the peritoneal cavity in the Sternberg bulbs before opening the encysted sero-purulent collection was found to be sterile.

Case VIII.—December 20, 1893. Male, twenty-one. No previous attacks. Present attack developed suddenly, with usual symptoms of an average severe case. Fever present from the commencement. Appendix found surrounded by adhesions and considerable sero-purulent fluid. Cavity of peritoneum well walled off. Smear preparations made directly from the exudate, and some of the exudate obtained directly with sterilized Sternberg bulbs. Appendix removed; ulcerated and perforated. Placed in sterilized glass tube. Recovery.

Bacteriological Examination.—Cultures made from the exudate on slanting agar, and from the exterior and interior of the organ all developed pure *bacillus coli communis*. The smear preparations show the same variety of organisms as the preceding case,—*i.e.*, a diplococcus, the *diplococcus lanceolatus*, a bacillus, the *bacillus coli communis*, and a streptococcus, probably the *streptococcus pyogenes*.

Case IX.—December 25, 1893. Male, seventeen. Chronic relapsing appendicitis operated upon in an acute relapse. Present attack came on ten days previous to admission to the hospital. Fever present since that time. Tumor present. Appendix found embedded in a mass of inflammatory adhesions. Appendix removed.

Bacteriological Examination.—Cultures made as before. Result, pure *bacillus coli communis*.

Case X.—December 25, 1893. Female, twenty-one. No previous attack. Present attack sudden and accompanied by usual symptoms. Fever from commencement of the attack. Appendix infiltrated. No adhesions. No perforation. Recovery.

Bacteriological Examination.—Pure cultures of *bacillus coli communis* obtained from walls and interior of appendix.

Conclusions.

(1) The *bacillus coli communis* exists constantly in the lumen of the appendix and also in the exudate in the peritonitis accompanying inflammations of that organ. This can be demonstrated both by direct examination and by cultures.

(2) Other bacteria than the *bacillus coli communis* exist constantly in the exudate, and can be demonstrated by direct examination, but very rarely by culture.

(3) That perforative peritonitis from appendicitis is not a mono- but a poly-infection, and that, while the *bacillus coli communis* probably has the largest share in the infection, the presence of other organisms cannot be ignored.

DESCRIPTION OF PLATE II.

FIG. 1.—Acute and rapidly-progressive appendicitis, with gangrene and perforation.

FIG. 2.—Interior of the same; the mucous membrane of the appendix at its middle is in a gangrenous condition; at the proximal and distal portions beginning necrotic changes are observed.

FIG. 3.—Acute perforative appendicitis.

FIG. 4.—The same, showing gangrene of the entire mucous membrane lining the organ.

Plate II.

Fig I

Fig. II.

Fig III.

Fig IV.

DRAWN FROM NATURE BY F. A. DECK.

CHAPTER VIII.

The Pathological Anatomy of the Appendix Vermiformis.

By Dr. J. M. Van Cott, Jr.

Two great classes of facts must always form the basis of knowledge concerning the disease of an organ, or part,—*i.e.*, first, the anatomy, gross and microscopic, and the physiology of the part; second, the general pathological laws governing tissue lesions.

The appendix vermiformis is in effect a diverticulum from the caput coli, and retains practically the structure of this part of the large gut.

The exact location of the appendix has been fully described in another part of this monograph. (*Vide supra.*)

The vermiform appendix is possessed of four coats:

(1) A serosa, continuous with and resembling that of the caput coli.

(2) A muscularis, composed of (*a*) an outer sheath of longitudinal fibres, and (*b*) an inner sheath of circular fibres. *a* is much thinner than *b*, and both *a* and *b* are composed of non-striated muscle.

(3) A submucosa similar to the general submucosa of the intestinal canal.

(4) A *mucosa propria*, resembling that of the large intestine, with the exception that it contains quite constantly solitary lymph-follicles in varying numbers. These latter may also be present in the submucosa.

The histology of these four tunics is identical with that of the large intestine, with the two exceptions of the greater constancy of the solitary lymph-nodes in the mucosa, and the complete outer sheath of longitudinal fibres in the muscularis.

The appendix is rich in minute blood-vessels, lymphatics,

and nerves, the latter being the plexuses of Meissner and Auerbach.

Usually the appendix is supplied with a meso-appendix, which assumes the shape of a triangular web having one free and two attached borders. This membrane forms a stroma supporting the vascular and nervous supply to the part. It often contains considerable adipose tissue, and sometimes lymphatic glands.

The circulation in the appendix is practically a terminal one, the great volume of blood passing to it (Plate III, Fig. 1) through a single branch of the mesenteric artery, only slight collateral circulation deriving through continuity of structure with the caput coli.

In women a third source of blood is found in the appendiculo-ovarian ligament, which carries an artery to the appendix. Lymphatic channels are distributed throughout the meso-appendix.

Relatively large nerves also course with the blood-vessels, and must be regarded as motor, sensory, and trophic.

Stimulation by us of the nerve in the healthy appendix of a dog was immediately followed by erection of the part.

One other circumstance in the anatomy of the appendix, fully treated of in another chapter, may be mentioned here,—*i.e.*, that the blind or distal end of the appendix has normally no attachment, thus allowing free motion of the part.

Physiologically the appendix functionates in a manner similar to the large gut, only to a less degree. Peristalsis and secretion of mucus cover the ground as far as we know.

Such classified facts make it certain that this part of the anatomy *must* be subject to the same great pathological laws which govern all tissues; so that it may be logically concluded that certain pathologic conditions obtain here as elsewhere, and are susceptible of classification according to definite system.

Lesions of the appendix are thus described as—

(1) Hypoplasias.—General anomalies of formation, considered elsewhere in this book.

(2) Circulation disturbances,—oligemia, hyperemia.

(3) Non-specific inflammation,—*a*, catarrhal; *b*, purulent; *c*, fibrinous; *d*, combinations of *a*, *b*, *c*; *e*, interstitial.

(4) *f*, tubercular; *g*, typhoid, etc; specific inflammation.

(5) Progressive nutrition disturbances,—consecutive hyperplasia of any or all of the tunics; neoplasms, of which latter, carcinoma, endothelioma, sarcoma.

(6) Regressive nutrition disturbances,—atrophic changes, involving any or all the coats, from deficient vascular or nervous supply.

(7) Foreign bodies,—enteroliths, accidental substances.

(8) Parasites.—The various intestinal micro-organisms.

That these conditions do exist in the appendix has been repeatedly shown by many investigators; and reference to those of Dr. Fowler's cases, which have been subjected to exact examination, will demonstrate most of the lesions in the above enumeration.

The one point of keenest interest in the question of appendix pathology is this,—namely, Why, if the vermiform appendix corresponds so closely in structure with the rest of the alimentary canal, is it so much more frequently the seat of lesion than any other portion of the tube? Why, if the same pathological laws govern the appendix tissue that govern the other tissues of the body, do they assert themselves so much more frequently here than elsewhere?

There is one prime cause which more than any other is responsible for this fact, to wit, that here as nowhere else—certainly in the abdominal cavity—the parts involved are peculiarly exposed to vascular and nervous, and hence nutrition disturbances. Careful examination of Dr. Fowler's specimens has convinced me that vascular and nervous lesions of the meso-appendix are common and potent factors to ultimate disease of the appendix itself; it is a very striking fact, that women are less frequently stricken with appendicitis than men, and that, as already stated, they have an extra supply of blood from the appendiculo-ovarian ligament; a fact bearing very directly on the question of nutrition.

As a whole, the (thirteen) cases sent me by Dr. Fowler for examination reveal the presence in the meso-appendix vessels of

some form or other of obstruction to the blood-current, either para-, peri-, or endovasculitis, or organized thrombus; conditions which must, in the nature of the case, have long preceded the intense small round-cell infiltration, the coagulation necroses, and purulent foci, present in the walls of the appendices themselves. (Plate V.)

In several cases also a distinct neuritis interstitialis chronica supervened, in some the hyperplastic, endo-, and perineurium being so abundant as to have caused extensive atrophy of the nerve-fibres. (*Vide plate* IV.)

It is indisputable that such lesions of vessels and nerves can only result ultimately in a most profound trophic disturbance of the appendical tissues, with lessened resistance, and localized necrosis. Why the appendix, for example, should be free from the consequences of anæmic infarct, so certain in the renal and other tissues endowed with a terminal circulation, is difficult to see. On the other hand, if the trophic fibres, which must exist in the nerves of the meso-appendix, be subjected to pressure through hyperplasia of their connective-tissue sheaths or general connective-tissue hyperplasia, to the extent of causing atrophy, trophic changes are bound to occur in the appendix itself, and will be co-extensive with the nerve lesion.

The results of vascular obstruction are directly analogous to *ulcus ventriculi* dependent upon endarteriitis of the gastric vessels; those of trophic nerve lesion, to *ulcus perforans*, due to trophic nerve lesion of an extremity.

It has been shown in another chapter that the great mobility of the appendix and its mesentery renders these structures liable to torsion, and it can scarcely be doubted that this stands in direct etiologic relation with the vascular and nervous degenerations.

Assuming the correctness of these conclusions, it is evident that two things are possible: (1) The real cause of the *locus minoris resistentiæ*, which admits of bacterial infection of the appendix, must be sought primarily, not in a trauma of the mucosa, but rather in trophic disturbance of the appendix, resulting from (*a*) chronic vascular lesion, or (*b*) chronic nervous

lesion, or (*c*) both; and (2) that this trophic disturbance will be intense or moderate, depending upon the nature of *a*, *b*, or *c*. Hence it must follow that ulcerative processes in the appendix, while they may be increased by bacterial invasion, may nevertheless owe their origin to the trophic conditions. So that it must always be difficult to prove that a given ulcerative process or pus-focus in the appendix is due to bacterial invasion primarily; and the more especially is this true when lesions of the meso-appendical vessels and nerves obtain.

It would seem much more cogent reasoning to assume that bacterial invasion were made possible by the lessened resistance of the part through defective nutrition than that primary necroses were the result of direct invasion of germs through a normal mucosa.

Reasoning from the findings in Dr. Fowler's cases, another source of trophic disturbance lies in a progressive hyperplasia of the coats of the appendix, probably due to repeated hyperemia, or chronic stasis through defective venous return in the meso-appendix: primary conditions which must eventually result in the vascular and nervous lesions already described.

Other causes are also unquestionably operative in producing necrosis of the mucosa, with consequent infection, as, *e.g.*, angulation of the appendix, the presence of foreign bodies in the lumen of the part, enterolith, etc. Here a local oligemia results from local pressure. These causes are less frequent than the meso-appendix lesions.

The attempt to show that a specific bacterium exists which is responsible for appendicitis has failed; and it is now known that, when microbic infection occurs, it may be simple or mixed, and that several varieties of organism may find their way into the peritoneal exudate at once. This goes far to prove the presence of other primary causes of appendicitis than germs, and strengthens the assumption that the imperfect local tissue nutrition and lessened resistance are operative to the production of the inflammation, *because of the vulnerable points they open to the invasion of bacteria*.

Consideration of the so-called "relapsing" cases of appen-

dicitis throws light upon the whole subject,—not only in its pathology, but also in the practical deductions which should aid the surgeon in his decision regarding operative interference,—deductions which can only be drawn from exact knowledge of the pathology at hand.

These cases behave in a manner entirely consistent with the macroscopic and microscopic findings. The meso-appendix is hyperplastic, and the appendix itself is also in many instances the seat of progressive hyperplasia. Everywhere new-formed connective tissue is at hand, and the vessels regularly show hyperplastic changes, involving sometimes all and sometimes one or two of their coats. The same lesions are observed in the nerves. Similar lesions in the liver or kidney would be called cirrhosis.

As time lapses, there is a general tendency to progression; until finally that which was at first too slight to give much semiology suddenly asserts itself with an explosion of pain, marked reflex symptoms, vomiting, shock, etc., and in some cases temperature and other evidences of sepsis.

It cannot be certainly said that, in every first attack, or in the succeeding attacks, infection has occurred. That this is true is evidenced by the clinical fact, that fever and other symptoms of infection are not always at hand; and abundant analogy goes to show, that the pain and muscular spasm may be the direct result of the progressive nerve lesions and resemble the "crises" of similar lesions elsewhere. Assuming that these lesions do exist in the meso-appendix, it never can be known just when the trophic disturbance is to result in necrosis of some area of the mucosa, nor can the exact extent of the necrosis be estimated, so that, with the first attack, where diagnosis is reasonably certain, it may be definitely stated that a condition is at hand, liable at any time to assume most threatening proportions, and which must eventually result in disaster. It is perfectly supposable from this view of the question that small areas of the mucosa may from time to time become thus necrosed, and that local infection will result. What is to follow such a process will depend on two facts: (1) The amount of resistance in the appendix as a whole, —*i.e.*, the general condition of its vascular and nervous supply,

and hence its nutrition; and (2) the potential energy or virulence of such parasites as may happen to be lurking in the lumen of the part at that time. It is obvious that these two points can scarcely be determined *intra vitam* with any certainty, for the reason, that such clinical symptoms as pain and temperature are by no means in constant ratio with the extent of the lesion. From this the deduction follows that, after the first attack, an individual smitten with this form of appendicitis is never safe; and in this connection it should be remembered, that during such attacks adhesions may be formed, which not only tend to increase the lesion in the meso-appendix, but may very seriously modify subsequent operative possibilities, so that it is far more logical to proceed at once under aseptic and antiseptic precautions and skilful technique to remove the appendix, thus avoiding the constant danger of fatal general infection on the one hand, and serious difficulty consequent upon delayed operation through formation of adhesions, etc., on the other.

Of the circulatory disturbances in the appendix it may be further said that oligemia will supervene where progressive obliterating endarteriitis is at hand, or where torsion is severe, or where a foreign body is present in the lumen of the tube; while hyperemia may originate either from tension on, or obstruction in, the vein, or secondarily as a result of local infection. Both conditions may obtain as a result of nerve-lesion. (*Vide supra.*)

That these conditions can produce profound effect upon the vitality and resistance of the appendix has already been shown. (*Vide supra.*)

In speaking of "non-specific inflammation," it is not intended to convey the idea that bacteria play no *rôle* in the process, for it is beyond dispute that they always do. The point here lies in an effort to discriminate between appendicitis resulting from such organisms as tubercle bacilli, and those forms of appendicitis in which the several pyogenic organisms seem equally competent to produce the lesion, and do so in conjunction with the trophic changes.

Summing up all these facts, it is evident,—

(1) That appendicitis often results primarily from circulatory

and nervous disturbances, which greatly lower the resistance of the part; and that the vascular and nervous disturbances are due either to immediate torsion of the meso-appendix or chronic progressive hyperplasia of the same.

(2) That the nature of the inflammation in the given case will be *a*, *b*, *c*, *d*, *e*, *f*, or *g*, depending upon, first, the degree of circulatory and nervous disturbance, and, second, the nature of the parasites present. (*Vide supra.*)

(3) That it never can be certainly known whether in the given case of acute appendicitis this initial attack is resultant from sudden torsion, angulation, pressure of foreign body in the lumen of the appendix, or *the first warning of a chronic productive meso-appendicitis, with progressive trophic lesions of the appendix.*

(4) That weighing the chances of general infection of the peritoneum, or the system at large engendered by delay, with those of infection from a properly-conducted operation, the decision must, from a pathological stand-point, be in favor of operation.

Of the pathological anatomy of the appendix, aside from inflammation, there are a few points of diagnostic value.

The nature of certain progressive and regressive nutrition disturbances has already been discussed. Of the neoplasms, it is to be remembered that carcinoma, endothelioma, and sarcoma have been reported; and, while there are too few cases on record as yet for statistical purposes, the possibility of a real neoplasm must always be a factor in the differential diagnosis of appendicitis. Of foreign bodies popularly supposed to slip into the appendix, it is generally admitted that this accident only seldom occurs. Fecal impactions are more common, but even these are only present in a relatively small percentage of cases.

Finally, reference to the findings from microtome sections of Dr. Fowler's cases should convince the earnest inquirer into the real nature of appendicitis of the correctness of these views. These findings are illustrated by the accompanying plates which represent camera drawings from sections prepared according to the usual technical methods, and also photographs of gross material.

DESCRIPTION OF PLATE III.

FIG. 1.—Photograph of normal appendix vermiformis with its meso-appendix intact; from a child aged 14 years.

(1) Meso-appendical artery and vein, coursing the free border of the meso-appendix. (2) Straight vessels given off from these to the appendix, which supply a dense plexus of minute vessels to the meso-appendix, a system of perforating vessels to the four coats of the appendix, and a superficial plexus to the serous coat of the same. (3) Dense net-work of fine vessels,—arterioles and venules,—which are in the connective tissue of the meso-appendix, and everywhere accompanied by trophic nerves. The figure demonstrates clearly the terminal nature of the circulation.

FIG. 2.—Photograph of an appendix, the seat of recurrent inflammation, which has attached to it the major portion of its meso-appendix. This latter—the extent of which is marked by 4, 4^1—is everywhere hyperplastic, containing a large amount of adventitious white fibrous and adipose tissues.

5 marks a distended annular portion of the appendix, the coats of which are thin and atrophic.

5^1 marks an annular area which shows exactly the reverse of this condition, the coats being thickened and contracted.

6 marks another area resembling 5, which has finally perforated.

There is a small amount of fresh lymph over the serous surface of the appendix, and upon the meso-appendix.

Inspection of Fig. 1 makes it clear how torsion of the meso-appendix can readily produce localized oligemia when severe, and vascular stasis when only sufficient to obstruct capillary and venous return; while inspection of Fig. 2 would seem to show the inevitable effect of chronic productive inflammation and the resulting mechanical interference with the circulation.

PLATE III.

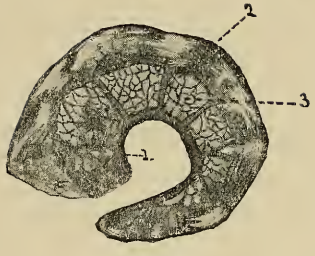

FIG. 1.

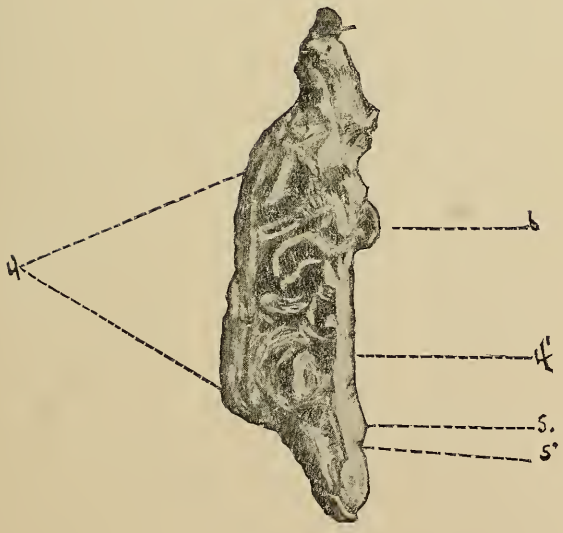

FIG. 2.

J. M. VAN COTT JR., PHOTO. DE NAT. HOAGLAND LABORATORY.

DESCRIPTION OF PLATE IV.

FIG. 1.—Camera drawing of a transsection of a nerve in the hyperplastic meso-appendix of a chronic relapsing appendicitis.

Zeiss Apochromat. Sys. Oc. 4, Obj. 4 mm. Scale, .010 mm. ÷ 10.

a.—Granulo-hyaline exudate thrown out between the perineurium and nerve-fibres, and seen to contain certain large granular epithelioid elements.

a^1—Thickened perineurium, composed of hyperplastic connective tissue.

b.—Nerve-bundle, showing a diffuse endoneuritis, and extensive atrophy of the nerve-fibres, which appear compressed by exudate.

FIG. 2.—Camera drawing of nerve in transsection, also from the hyperplastic meso-appendix of chronic appendicitis.

Conditions of drawing similar to Fig. 1.

a.a.^{1}*—Peri- and endoneural connective-tissue hyperplasia.*

b.—Wide-spread nerve atrophy.

PLATE IV.

FIG. 1.

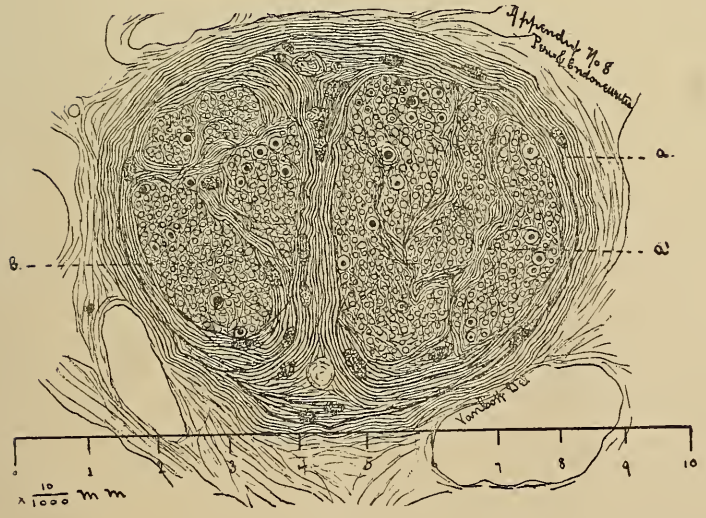

FIG. 2.

J. M. VAN COTT, JR., DEL.

HOAGLAND LABORATORY.

DESCRIPTION OF PLATE V.

FIGS. 1, 2, 3.—Camera drawings of transsections of vessels in the meso-appendix of two cases of chronic appendicitis, and the submucosa of another, in which the process is much younger.

Conditions of drawings similar to those of Plate IV.

FIG. 1.—Arteriole from an area of coagulation necrosis in a hyperplastic meso-appendix; acute exudative appendicitis having been superinduced on the chronic lesion by perforation.

a.—Greatly reduced lumen of vessel.

a^1.—Hyperplastic endothelium of intima.

The whole vessel shows characteristic changes due to coagulation necrosis.

FIG. 2.—Sclerosed arteriole, containing thrombus in granular degeneration, *a*,—in the centre of which is a white cell.

a^1.—Thickened intima, with hyaline infiltration.

a^{11}.—Fibroid degeneration of media. The whole vessel is reduced in size, the lumen small, irregular, eccentric; while the coats are thickened.

FIG. 3.—Arteriole from the submucosa of an appendix in which an acute attack supervened without perforation; only intense hyperemia and dulling of serosa being visible. The meso-appendix was in the early stage of hyperplasia, and the seat of considerable small round-cell infiltration. This vessel is an exquisite example of endarteriitis obliterans. The smaller vessels of the submucosa in this case were many of them far advanced in sclerosis, and there are small foci of intense, small round-cell infiltration and necrosis in the mucosa,—miliary abscess (?).

a.—Very small, irregular, and eccentric lumen.

a^1.—Irregularly thickened intima at the circumference of which is a layer of yellow elastic tissue.

a^{11}.—Media showing moderate small round-cell infiltration, and an early stage of fibroid degeneration.

In this case evidently a process is commencing, the later stages of which are shown in the appendices of 1 and 2; and the case is just such an one in which repeated attacks with recovery (?) may occur, until the final perforation with severe consequences takes place.

PLATE V.

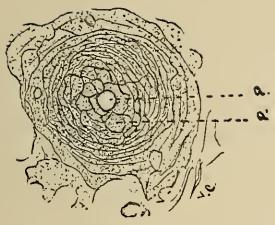

FIG. 1.

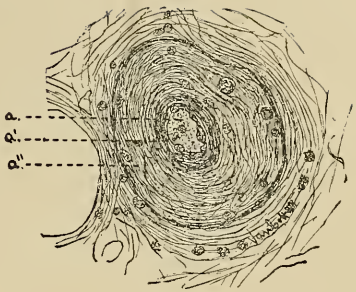

FIG. 2.

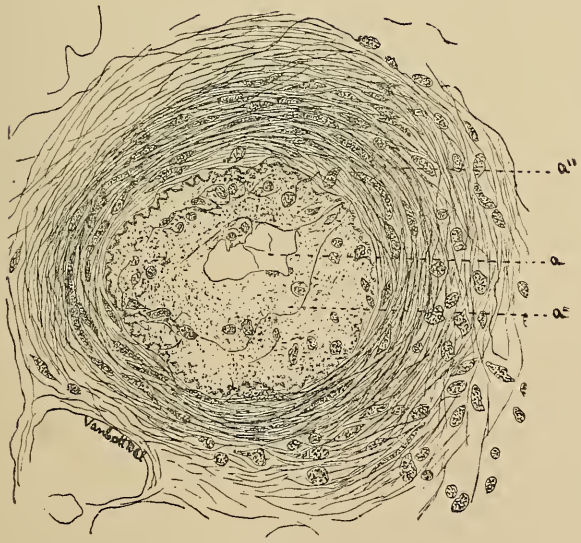

FIG. 3.

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CHAPTER IX.

The Diagnosis of Appendicitis.

The diagnosis of acute appendicitis is to be based upon the following symptoms: First, the suddenness of the attack; second, the occurrence of acute abdominal pain; third, tenderness at the site of the appendix; fourth, the occurrence of nausea and vomiting, either accompanying or following the pain.

The location of the pain is of special diagnostic value. In the great majority of cases it is at first referred to the region of the umbilicus, and to the epigastrium. In the course of a few hours, however, it becomes centred in the right iliac region, although more or less abdominal pain may still be complained of. The pain, as already mentioned, is acute, in the sense that it is sufficiently severe to transcend the powers of endurance of an average individual, and to demand measures of relief at the hands of the medical attendant.[1] The severity of the pain, the suddenness of the onset, the fact that it is referred to the epigastrium, or thereabouts—in addition to these, the occurrence of nausea and vomiting may distract the attention of the physician from the appendix vermiformis altogether. Prior to the last five years the diagnosis of acute indigestion or of a "bilious attack" was made in a large majority of these cases.

The character of the vomited material will vary with the ingesta. The stage of digestion reached, as shown by the vomited material, will correspond very closely with the time which has elapsed since the last meal was taken. In other words, the vomiting is not that of indigestion.

The patient assumes the dorsal decubitus almost without exception. Inspection, even at the very commencement of the disease, will frequently reveal, during the respiratory act, some

[1] With the appendix extra-peritoneally located, the pain at first may be dull in character. Peritoneal involvement gives rise to acute and lancinating pain.—(J. D. Bryant.)

limitation of movement on the part of the abdominal muscles, particularly upon the right side. This feature, however, may not be marked if opium has been freely administered. If it be permitted to manifest itself, it will become more and more marked as the disease progresses. Because of this limitation of movement on the part of the abdominal muscles concerned in the act of respiration, thoracic respiration becomes a feature of the attacks to a greater or less extent. With the patient narcotized with opium, the entire absence of this symptom is not to be relied upon as evidence against the existence of the disease.

In more advanced stages of the disease, adhesions having taken place, together with some inflammatory exudation, fulness opposite the anterior superior spine of the ilium, and beneath the right rectus muscle, will be observed. This may also be apparent along the line of Poupart's ligament, particularly in thin subjects. In cases in which the inflamed appendix lies upon the flexor muscles of the thigh as they pass along the posterior limits of the iliac fossa, the right thigh, or even both thighs, may be flexed. That this symptom does not possess the diagnostic value formerly attributed to it, however, is shown by the fact that in two instances coming under my observation, in which the post-peritoneal connective tissue was the seat of a large purulent collection, this symptom was entirely absent. In both cases the appendix was extra-peritoneally situated.

The patient's facial expression is not usually indicative of a serious abdominal lesion in the first stage of the disease, but with the advance of the latter the characteristic anxious look of peritoneal inflammation develops (facies abdominalis, facies Hippocraticus).

Progressive abdominal distention, as the peritonitis becomes less and less localized, develops with the advance of the disease, and intestinal paresis becomes more and more marked. As a consequence the abdomen becomes rounded, and sometimes even barrel-shaped, significant of general peritonitis.

Abdominal distention may be due to the constipating effects of opium, or to an accumulation of gas, without the occurrence of peritonitis. This will give rise to much discomfort, but other

symptoms of general peritonitis will be absent. Richardson, of Boston,[1] advises auscultation of the abdomen in differentiating between the two conditions. Where the distention is due to paralysis of peristalsis due to peritonitis and sepsis, no sounds whatever will be heard on auscultation. On the other hand, where the distention is due to the less grave condition, there is no inhibition of peristalsis, and evidences of intestinal action will be obtained.

Palpation shows tenderness in the right iliac fossa, and a sensation of tension or even rigidity is imparted to the palpating hand in certain cases by contact with the muscular walls of the abdomen, particularly the right rectus muscle. Pronounced tenderness in the right iliac fossa, unless masked by the administration of opium or some other equally powerful narcotic, is almost as pathognomonic of appendicitis as rusty sputum is of pneumonia. Involuntary muscular tension is not equally marked in all cases in the beginning of the disease. The presence or absence of this symptom seems to bear some relation to the proximity of the inflamed appendix to the anterior abdominal wall and to the extent to which the patient has been narcotized by opium in the treatment.

The sensitiveness will be slight or well marked according to the stage of the disease, and the severity of the attack. This is the feature of the disease which forms the best diagnostic guide, and indicates more than all the other symptoms combined the progressive character of the attack. Its increase from day to day, and sometimes even from hour to hour, denotes increase in the gravity of the case. On the other hand, marked and rapid lessening of the tenderness both in intensity and in area (providing always that this symptom is not being masked in the particular case by the narcotic effects of opium), indicates, other things being equal, a subsidence of the inflammatory action.

The tenderness may be present over an area as large as the palm of the hand, even in the first few hours of the attack, but as a rule it is limited at this time to a point near the centre of the

[1] The American Journal of the Medical Sciences, January, 1894, p. 7.

right iliac fossa. Here its presence will be determined by pressure with the points of the fingers.

Providing the case is seen sufficiently early to permit with safety of the necessary manipulation, the following method of examination will be found to give the most satisfactory results:

The tips of the fingers should be laid flatwise upon the abdominal wall and steady pressure made directly backward until the smooth regular surface of the iliac fossa is felt. The finger tips are moved about, the abdominal wall moving with them, and the fossa thus explored. Pressure made in this manner may be repeated until the entire right half of the abdomen has been systematically examined. Tenderness at several points may be elicited.[1]

Exceptionally, by this method of examination, it is possible to identify the appendix in the interval between the attacks in cases of the chronic relapsing form of the disease. I have succeeded in thus identifying it, both in the class of cases above mentioned, and also in instances where abdominal section was about to be performed for conditions other than those relating to lesions of the appendix, and in which the latter was in a normal condition. When the abdominal muscles offer a very decided resistance to the palpating finger tips, this may be overcome by grasping this hand by the other, or disengaged hand, thereby reinforcing the former. Considerable pressure may thus be made in this class of cases, without that sacrifice of delicacy of touch which is apt to occur if one hand is relied upon both for forcible pressure and palpation. In persons with relaxed abdominal walls the iliac arteries and the appendix vermiformis may be made out with more or less distinctness. In persons with thick or rigid abdominal walls the identification of the appendix cannot be made out without the aid of an anesthetic, and even under these circumstances it becomes, to a great extent, a mere matter of guess-work.

[1] Although, heretofore, considerable stress has been laid upon the symptom of point-tenderness in the right iliac region, cases occasionally occur which illustrate the fallacy of placing too much reliance upon this as well as any other one symptom in the diagnosis of appendicitis.

As the disease advances another point of special tenderness develops parallel with Poupart's ligament, and just opposite and below the anterior superior spinous process of the ilium. This is due to adhesions which form between the dextral surface of the caput coli and cecum and the lateral pelvic wall. When pressure is made in this region there is greater dragging upon the parts adherent at this point than elsewhere, owing to the rigidity of the pelvic wall. Distinct tenderness nearer the median line, about the umbilicus or in the supra-pubic region denotes a corresponding position of the inflamed appendix. Tenderness limited to a very small spot may sometimes be elicited by placing the finger tip firmly against the abdominal wall and bidding the patient cough.

Treves has laid stress upon palpation through the rectum. I have been able in this manner to demonstrate a greater degree of tenderness upon the right than upon the left side. The "sausage-shaped" tumor described by Treves, I have seldom been able to make out. Generally speaking, it is not possible to demonstrate by means of a rectal examination in these cases anything which can not be made out much more satisfactorily by external examination; if the examining surgeon is to be the operator in the case he will do well to keep his finger out of the rectum.

Examination per vaginam when the disease attacks the female is thought to be of value by Lenander.[1] If the inflamed appendix lies upon the "S." or "S. E." line, and extends into the pelvis, the tumor may be felt from the cavity of the vagina. It will be exceedingly difficult in these cases, however, to differentiate by this method of examination between appendicitis and right-sided salpingitis or pyosalpinx; in fact, nearly all of the inflammatory lesions of the adnexa involve pain, tenderness and tumefaction. The appendix may even be involved in tubo-ovarian lesions.[2] Under these circumstances a differential diagnosis without exploratory laparotomy will be impossible.

Sensitiveness may be marked in locations remote from the right iliac fossa, due to an unusually long appendix in which the

[1] Upsala Lakareforen, Forhandl., Vol. XXVIII, part 1; Centralblatt für Chirurgie, No. 16, 1893.

[2] Richelot, Bulletin Société de Chirurgie, October, 1890.

inflammatory process is most marked at the tip, or to an abnormally-placed cecum. In addition to those cases in which non-descent of the cecum is present (the latter maintaining the position in which it lies in early intra-uterine life, namely, in the neighborhood of the umbilicus), this portion of the intestinal canal may be located in the right hypochondrium behind the liver. When this happens the tenderness may be most marked at varying distances above the transverse line "W. E."

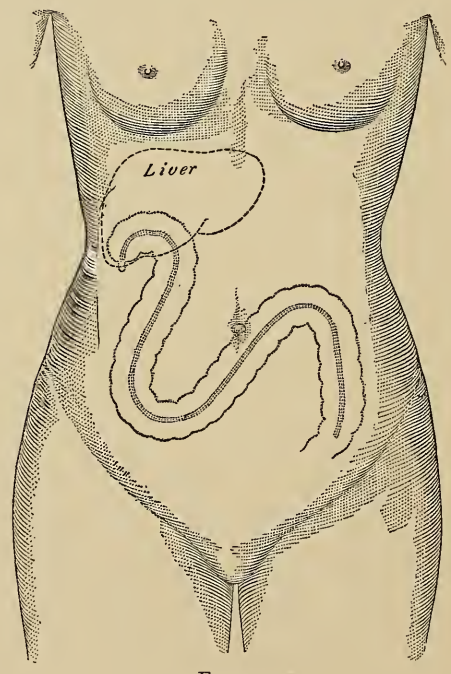

FIG. 12.

The following case, referred to me by Dr. F. E. Wilson, and operated upon at St. Mary's Hospital, illustrates this somewhat rare condition:

M. C. F., aged fifteen, developed the usual symptoms of appendicitis. There was marked tenderness at the site of the gall-bladder. She was seen by me on the third day of the disease and sent at once to the hospital for operation. Upon opening the abdomen and exploring its cavity the cecum could not be found in the right iliac fossa, but

FIG. 13.—Cystic dilatation of the appendix.

the transverse colon was found to descend to the level of the pubes, a portion of it occupying the usual site of the ascending colon. An attempt to follow the colon at first resulted in tracing it to the splenic flexure. I then examined it in the opposite direction, and succeeded in finding the cecum immediately behind the liver. The liver was held out of the way by my assistant, and the appendix cleared from its surrounding adhesions and removed. (Fig. 12).

The presence of a tumor may be made out by palpation, provided the disease has advanced sufficiently far to make this symptom available, or the rigidity of the right rectus muscle is not so great as to mask its outline. There should be but little liability to mistake in the male when the tumor has once been made out and due weight has been given to the history; in the female it is different. Here the condition may so closely resemble a right-sided pyosalpinx that the most skilful diagnostician may be at fault, particularly in those cases in which a long appendix passes down into the pelvis. Fluctuation is rarely made out.

Exceptionally a tumor may be felt at an early period of the case, especially in patients with more than usually thin abdominal walls, and in whom the symptom of rigidity of the right rectus muscle is absent.

A case illustrative of this was admitted to my service at the Methodist Episcopal Hospital, on October 6, 1893.

A tumor was distinctly made out by the attending physicians, Drs. Mains and Sturges, on the afternoon of the day following the attack, twenty-nine hours after the first symptoms. The tumor was located directly behind the internal abdominal ring, was very tender to the touch, and appeared from external palpation to be the size of a small hen's egg. It was somewhat freely movable. Its localization was greatly facilitated by the entire absence of rigidity of the right rectus abdominis muscle. A right lateral laparotomy (oblique incision) revealed an appendix in the "S." position, the seat of a cystic dilatation at its proximal end. The dilated portion was about the size of a small walnut (Fig. 13). There was complete absence of adhesions, except the attachment of a portion of omentum to the sinistral side of the appendix.

Lumbar tenderness may be more or less marked according as the peritoneum be involved in this locality, or as the inflammation extends into the post-peritoneal connective tissue. Under ordinary circumstances the symptom of lumbar tenderness is not of great diagnostic value, except as a means of assisting in establishing the probable location of the appendix before an operation.

Percussion will give a note, high-pitched, dull, or even flat, when extensive and dense adhesions have formed, or when suppuration has occurred in these adhesions as a result of an infection from the appendix. This percussion note becomes more marked with the advance of the disease, and as the adjoining coils of the intestine give a note which is tympanitic by comparison. In cases in which an extensive and diffused serous effusion into the peritoneal cavity occurs, dulness may be found on percussion over the latero-dorsal portions of the abdomen.

In percussing the region of the colon and cecum the fact should be borne in mind that impacted fecal matter in this locality may simulate a tumor due to appendicitis. Tenderness may also be present due to impacted feces.

Exploratory puncture is to be mentioned only to be condemned. Its employment adds a new element of danger to the case, while its results are unreliable, and calculated to lead the surgeon into error, particularly if these be negative.

The occurrence of fever is of some diagnostic importance in determining the presence of the disease, when taken in conjunction with the other symptoms; but, unfortunately, when not of a high degree it cannot be relied upon as an indication of the character or extent of the inflammatory process. A slight rise of temperature is not incompatible with early and fatal perforation. Again, this, together with the subjective phenomena may disappear almost entirely, and yet the life of the patient be in the greatest jeopardy. Cases which do not pass beyond the first stage, and are of a very mild type, may be afebrile, yet even these will bear watching very closely.

Differences in temperature between that of the axilla and the mouth on the one hand, and that of the rectum and the vagina

on the other, should always be taken into account in cases of suspected appendicitis. A difference in favor of the latter localities of more than a degree and a half may be regarded as diagnostic (Madelung), although the absence of this symptom is not to be regarded as significant.

The occurrence of a chill is of such slight importance during the first stage of the disease, as not to merit particular notice in this connection. Even in the subsequent stages when suppuration is in progress it cannot be regarded as a frequent nor as an important symptom. The clinical fact that intra-peritoneal suppuration does not give rise to chills or chilly sensations, much less to a rigor, as frequently as do suppurative processes elsewhere, may here be noted.

In the average typical case of appendicitis there should be no greater difficulty in making a diagnosis than the physician ordinarily finds in arriving at a conclusion in a case of pneumonia.[1] Every case of colicky pain in the abdomen, suddenly developed, with right-sided tenderness, should be regarded as a case of appendicitis until this supposition be disproved. The accusation should be made, as it were, and the burden of proof should be placed upon the appendix to show its innocence. Every peritonitis is of traumatic origin, whether localized or diffused. All cases of peritoneal inflammation occurring without well-established determining causes other than this, should be ascribed to some lesion of the vermiform appendix.

In order to facilitate the diagnosis in doubtful cases, it may be useful to place before our minds in this connection the various conditions for which appendicitis may be mistaken.

Indigestion.—This has already been dwelt upon. Too much stress, however, cannot be laid upon the importance of looking beyond the stomach itself in order to account for epigastric pain and vomiting.

Pneumonia and Diaphragmatic Pleurisy.—Professor Janeway, at a meeting of the New York Academy of Medicine, in the course of a discussion upon appendicitis, stated that he had known this error in diagnosis to occur.

[1] Talamon.

Rupture of the Gall-bladder.—This error was made in one of my own cases of laparotomy. The accident occurred while the patient was intoxicated, and no definite history could be obtained other than the sudden occurrence of general and severe pain. The tenderness was right-side, and this, together with the rigidity of the right rectus muscle, and the existence of peritonitis, led to an exploratory incision which revealed the true state of affairs.

Hepatic Colic.—An error of diagnosis may easily be made during the paroxysm of acute pain in appendicitis by mistaking the attack for hepatic colic. The prominent general symptoms of sudden onset, paroxysmal pain, nausea and vomiting, rigid abdominal wall, prostration and an anxious facial expression in rapidly developing appendicitis are common to both. So far as the last three symptoms are concerned, their occurrence is so uniformly present, and so similar in the two conditions, that they may be dismissed as offering no diagnostic advantage. With care an error in diagnosis should not last longer than twenty-four hours, at the end of which time the localization of the symptoms of pain in the right iliac fossa and tenderness at or near McBurney's point, is complete.[1]

The same remarks will apply to the occurrence of nephritic colic upon the right side. This is more likely to confuse the diagnosis than hepatic colic.

The following table will show at a glance the points of the differential diagnosis of hepatic colic, nephritic colic, and the initial stages of appendicitis:

[1] The location of McBurney's point is determined as follows: A line drawn from the centre of the umbilicus to the anterior superior spinous process of the ilium of the right side is made to intersect a second line, vertically placed and corresponding to the outer edge of the right rectus abdominis muscle. The maximum point of tenderness will usually be found where these lines cross each other. If difficulty is experienced in accurately locating the outer margin of the right rectus muscle, McBurney's point may be located by placing the tip of the thumb upon the iliac spine and the tip of the middle finger upon the umbilicus. The index finger is now brought to a right angle and will touch the abdominal surface at McBurney's point (about midway between the two points mentioned). While the base of the appendix may not always correspond exactly to this point, yet the symptom of point tenderness thus located is of diagnostic value when taken in connection with others.

TABLE OF COMPARISON BETWEEN:

APPENDICITIS.	HEPATIC COLIC.	NEPHRITIC COLIC.
Pain.—Peri-umbilical, and referred to the epigastrium as well. Does not radiate above these points. Fixed point of pain in the right iliac fossa.	*Pain.*—Referred to the epigastrium, and radiates toward the shoulder and the point of the scapula. Starts from the region of the gall-bladder as a fixed point.	*Pain.*—Radiates towards the groin and testicles, and sometimes to rectum, giving rise to desire to go to stool, and to tenesmus.
Sensitiveness. — Greatest in right iliac fossa. Point pressure reveals an especially tender point upon the outer edge of the rectus abdominis muscle, just below the omphalo-spinous line (McBurney's point).	*Sensitiveness.*—Extreme beneath the lower border of the ribs. Tenderness over gall-bladder.	*Sensitiveness.*—Greatest posteriorly over the pelvis of the kidney. If tenderness exists in front it is greatest over Poupart's ligament.
Vomiting occurs, but is not persistent, as a rule.	*Vomiting.*—Frequent and intractable.	*Vomiting* not a frequent nor a prominent symptom.
Bladder and Testicle.—Symptoms very rarely present.	*Bladder and Testicle.*—Symptoms absent.	*Bladder* irritable; dysuria and vesical tenesmus; occasionally hematuria. *Testicle* retracted.

Floating Kidney upon the right side, with twisted pedicle, may be eliminated by very much the same line of reasoning as in renal colic. The history of a movable tumor, existing before an attack, will assist in the diagnosis.

Intestinal Obstruction is suggested by some of the symptoms of appendicitis, particularly if the point of the obstruction is near the ileo-cecal region. The following cases of more than usual interest will serve to illustrate the difficulties of diagnosis in this condition:

J. W., aged twenty-nine, of previous good health, was suddenly attacked with violent abdominal pain referred to the right iliac region, and with vomiting. Upon the occasion of my visit he lay in bed in the dorsal position, his knees drawn up. and a most anxious expression upon his face. The skin was of a muddy color, cold, and bathed in perspiration. The finger-nails were blue. The pulse was rapid (130) and feeble; temperature 102° F. Fecal vomiting had been present for two days. No movement of the bowels nor passage of gas per rectum had occurred since the first day of the attack, five days previously. The abdomen was barrel-shaped, and highly tympanitic. There existed a point of especial tenderness in the right iliac fossa. No tumor could be made out. A provisional diagnosis of primary appendicitis, with subsequent intestinal obstruction, either from intestinal paresis

or angulation, was made. Exploratory laparotomy was advised and accepted.

A vertical incision at the dextral edge of the right rectus muscle was made, and the parts about the cecum were exposed. A number of coils of distended small intestine presented themselves. The intestinal obstruction was found to be due to an encircling band, consisting of an unusually long diverticulum (Meckels), the remains of the vitello-intestinal duct, which had become wrapped around a portion of the ileum close to the ileo-cecal valve. The tip of the diverticulum was attached to the mesentery of a portion of intestine which it grasped, by an inflammatory adhesion of recent occurrence.

E. A., female, aged twenty-four, married, had previously suffered from some intra-pelvic inflammatory lesion. She was admitted to my service, at the Methodist Episcopal Hospital, with a history of having been suddenly attacked with severe abdominal pain and vomiting five days before. The pain, at first general, was finally referred to the right iliac region. The vomiting was persistent and uncontrollable, but not stercoraceous. Obstinate constipation existed. Tenderness over the supposed site of the base of the appendix was well marked, and all attempts to divert the patient's attention from this point, when making pressure upon it, failed. On May 15, the day of her admission, a right-sided laparotomy was performed by my assistant, Dr. Delatour. The appendix was found to be normal. The small intestine was bound down by old adhesions in the pelvis and just behind the cecum. Separation of these relieved the obstruction, and the patient made a good recovery.

Cases of true internal hernia are comparatively rare. The following case is of interest from this fact, as well as because the symptoms were such as to convince the medical attendant that he had to deal with a case of appendicitis:

F. A. B., male, aged twenty-one, was admitted to my service at the Methodist Episcopal Hospital, August 21, 1892. Two days before he had been attacked with sudden pain, referred to the right iliac region, and with vomiting. The pain became so severe as to require hypodermatic injections of morphia for its relief. The vomiting became persistent, the constipation complete, and the prostration extreme. The treatment prior to his admission to the hospital had been mainly the administration of opium, but in spite

of this and the distention, tenderness was more marked beneath the right rectus muscle and below the level of the umbilicus than elsewhere. A median incision was made, and a hernia of a portion of the ileum into the fossa duodeno-jejunalis of Treves was found, with the musculus suspensorius duodeni of Treitz acting as a band. The patient failed to rally, and died at the end of twelve hours.

The inflamed appendix itself, by acting as a constricting band, may be the cause of the obstruction, and lead to uncertainty in the diagnosis, as is shown by the following case:

A. A., aged twenty-four, was admitted to my service at the Methodist Episcopal Hospital suffering from symptoms of intestinal obstruction. The attack had been marked at the beginning (seven days before his admission) by diffused abdominal pain, followed by vomiting, and finally by pain in the right iliac region. The vomiting persisted, and finally became intractable; the abdomen was distended and tympanitic; the facial expression was characteristic of a grave abdominal lesion; stercoraceous vomiting finally occurred. He was in a condition of great prostration at the time of admission. A median abdominal incision was made for exploratory purposes, and the cause of the obstruction was found to be the appendix. As a result of the inflammation, the tip of this organ had sloughed away, and the stump had become adherent to the mesentery of the ileum, just at its point of attachment, in such a way as to compress the latter against the cecum.

Acute mechanical obstruction, the result of internal hernia, ileus, invagination or strangulation by bands from old inflammatory adhesions, will give rise to symptoms that are characterized by their sudden onset and severity. The pain occurs in exacerbations, and is generally referred to the seat of the obstruction or to the neighborhood of the umbilicus. In the latter case the differentiation will be attended with greater difficulties in the first few hours of the attack than later on, when, if the case prove to be appendicitis, the pain will be centered in the right iliac region; while if intestinal obstruction be present, it will remain centered at the umbilicus or at the seat of the invagination or strangulation. As shown in the cases cited, if the latter chance to be at the site of the appendix the difficulties of diag-

nosis may be increased. On the other hand, the vomiting in appendicitis is not constant or easily provoked, as is the case in intestinal obstruction; in the latter there is also obstinate constipation, with inability to pass flatus. Later on, the vomiting, caused by the voluntary efforts made by the patient, changes to a regurgitation of fecal matter from the reversed peristalsis; the sufferer as he lies upon his side simply ejects from the angle of his mouth what passes into it from the esophagus

In invagination the occurrence of tenesmus and the passage of bloody mucus will aid in the diagnosis. A tumor may often be made out by both abdominal and by rectal palpation. In strangulation caused by a band of adhesion in the adult, the history of a previous attack of peritonitis will usually be obtained. In children, both band and malposition of portions of the intestinal canal, causing obstruction by strangulation, may result from fetal peritonitis. In ileus a history of pre-existing peritonitis is wanting. In acute intestinal obstruction from any cause with advancing peritonitis, a rapid and general distention occurs due to the combined effects of the mechanical obstruction and intestinal paresis; in appendicitis and its resulting peritonitis the distention is the result of intestinal paresis alone, and is less rapid in its development.

Dropsy and Empyema of the Gall-Bladder.—The symptoms of this condition may appear suddenly, and simulate an attack of acute appendicitis. The resulting tumor may reach as low down as the omphalo-spinous line, and the tenderness be limited to this point.

M. S., aged twenty-eight, female, was suddenly attacked during the night with acute abdominal pain which radiated to the right renal, lumbar and iliac regions. Vomiting followed the onset of the attack. The pains were allayed by very small doses of opium, but a tender tumor was found beneath the dextral edge of the right rectus muscle, directly opposite the anterior superior spinous process of the ilium. These symptoms were all reported to me by her family physician, Dr. Amador, on the second day of her illness. When I saw her the right rectus muscle was rigid, her temperature was 102° F., and her pulse was 120. She was removed to St. Mary's Hospital for

immediate operation. The usual right-sided vertical incision was made through the abdominal wall, and a distended gall-bladder was revealed. There was some peritonitis in the neighborhood, and adhesions existed between the gall-bladder and the adjoining coils of intestine, and also the omentum. The gall-bladder was placed abnormally low in the peritoneal cavity, and this fact, together with the unusually rapid symptoms, accounted for the ease with which the case was mistaken for one of appendicitis. The gall-bladder was incised, giving exit to about four ounces of colorless viscid fluid, and finally to some pus. The edge of the viscus was then sutured to the peritoneal wound. The case was one of occlusion of the cystic duct from impacted biliary calculus, which subsequently escaped with the discharges, together with an inflammation of the gall-bladder itself and an accumulation of secretion which subsequently underwent suppuration.

Dropsy of the gall-bladder, occurring in connection with the presence of a gall-stone occluding the cystic duct alone, may simulate, by an occasional remission of the symptoms, the chronic relapsing form of appendicitis :

W. V., aged sixty, female, was admitted to my service in the Methodist Episcopal Hospital, and the following history was obtained: Six weeks previously she was suddenly attacked for the first time with acute pain in the right hypochondriac and iliac regions, followed by nausea and vomiting. The pain was finally relieved by opiates and hot fomentations. During the following six weeks more or less pain and tenderness persisted, referred, as she expressed it, "to the right side." On October 31, 1893, two days prior to her coming under my observation, she suffered from a recurrence of the original symptoms. At this time Dr. Brinkman visited her, and discovered a tumor beneath the right rectus abdominis muscle, extending from a point about an inch above the level of the anterior superior spinous process of the ilium, along the ascending colon, for a distance of about three inches. Point-tenderness at the so-called McBurney's point was well marked; at no other point upon the anterior abdominal surface could such extreme tenderness be elicited. There was no jaundice.

A right-sided vertical incision exposed the tumor, which was found to be a distended gall-bladder. There was considerable peri-

tonitis in the neighborhood, and the gall-bladder lay over and upon the ascending colon, to which it was adherent. It was also united by adhesions to the right lobe of the liver. The gall-bladder was opened and emptied of about three ounces of clear, but rather thin mucous fluid. Further investigation showed the presence of a single gall-stone of a conical shape, without facets, and about the size of the last joint of the little finger. The apex of this stone was firmly fixed in the opening of the cystic duct.

With a history of preceding attacks of indubitable hepatic colic and the occurrence of pain referred to the hypogastrium and epigastrium at the commencement of the attack, the case may go on for a considerable time before symptoms of a sufficiently distinctive character are present to suggest even an exploratory incision, as shown by the following case:

M. R., aged fifty-eight, female, was admitted to St. Mary's Hospital with the following history: She had suffered from several attacks of hepatic colic in the past. About six weeks prior to my visit she was suddenly attacked with acute abdominal pain referred to the epigastrium and right hypochondrium. Since the attack she had been confined to her bed with exacerbations of fever and more or less pain referred to the right hypochondriac and iliac regions. A tumor was finally discovered in the latter; its fluctuating character could be distinctly made out by palpation through the abdominal walls. The bulging of the wall at this point was likewise most pronounced.

A right lateral laparotomy revealed a large collection of sero-purulent fluid in the right iliac fossa. Upon emptying this a small opening was found which passed dorsad to the cecum and toward the median line and communicated with another cavity to the sinistral side of the colon. This second cavity also contained a large collection of sero-purulent material.

Upon exploring the right iliac fossa the appendix vermiformis was found lying in the "S. E." position. A portion of the organ had become detached from the remainder and was readily lifted from its bed of adhesions and removed. No ligature could be applied, and, owing to the patient's unfavorable general condition, it was not deemed wise to continue the operation to the extent of removing the remainder of the appendix.

At no time during the patient's convalescence was there any

trace of biliary secretion in the discharges or upon the dressings. The occurrence of fecal communication retarded the recovery, due to sloughing away of the remainder of the vermiform process.

Extra-uterine Pregnancy.—The sudden rupture of the sac of a right-sided extra-uterine pregnancy may simulate appendicitis. The occurrence of great prostration, amounting in some cases to collapse, excessive thirst, air hunger, and other symptoms of internal hemorrhage, the menstrual history and the results of a pelvic examination will be sure to differentiate the two conditions.

Pelvic Hæmatocele.—Hemorrhage from the pampiniform plexus of the right side, will suggest, by the suddenness of the onset and the accompanying pain, an attack of appendicitis. If the hemorrhage is intra-peritoneal, a large quantity of blood may be lost in a short time, and the symptoms of active and excessive hemorrhage develop. In instances where the hemorrhage is extra-peritoneal, the more urgent symptoms due to rapid loss of blood will be absent. A more or less pronounced tumor with a rather doughy feeling, situated between the folds of the broad ligament and felt on vaginal examination lying in one or both lateral fornices, or in the cul-de-sac of Douglas, will be found. In addition to this, some irregularity in the menstrual period immediately preceding the attack, and in some cases the recurrence of the flow after the regular menstrual flow has ceased, will all be diagnostic points of value.

Morbus Coxarius.—The flexion of the thigh upon the abdomen, together with lateral inclination of the pelvis, occurring in young children, from whom it is difficult to obtain an intelligent statement as to the seat of pain and tenderness, may lead to an error confounding this disease with morbus coxarius (Gibney).

Typhoid Fever and Entero-colitis.—Attention to the cardinal symptoms of appendicitis and a knowledge of the clinical course of these affections will certainly prevent the intelligent practitioner from confounding an attack with typhoid fever or with entero-colitis, yet I have seen both of these errors of diagnosis made.

CHAPTER X.

The Prognosis of Appendicitis.

The prognosis of appendicitis is unfavorable in the cases treated non-operatively in proportion to the severity of the infection; and in the cases treated surgically in proportion to the delay in instituting operative interference.

While there are doubtless many cases of endo-appendicitis of a mild character which recover, it is equally true that a very large number of the cases which are lost, both with and without operation, were mild cases in the beginning of the attack. The disease may pursue an exceptionally rapid and uninterrupted course to a fatal termination in thirty-six hours from the beginning of the attack, as is exemplified by the following case:

O. P., aged fifty-eight, was admitted to St. Mary's Hospital at 9 P.M. on April 27, 1892. He was found by the ambulance surgeon sitting in a saloon suffering from acute abdominal pain. He had first felt the pain while straining at stool just before starting for work that morning. A diagnosis of appendicitis was made, and he was removed to the hospital for operation. He was given a hypodermatic injection of morphine on the way to the hospital. This caused so much relief that he afterward refused operation, although it was repeatedly urged upon him during the next twenty hours. The temperature, which upon admission was 102° F., fell, after the full effect of the opiate was obtained, to 99° F., and there remained. He was seized with severe pain at 6.30 P.M. of the day following, and died in collapse within half an hour, just thirty-six hours after the first evidence of the disease. The pulse just before this was 120.

The autopsy, conducted by Dr. Clayland, the assistant pathologist of the hospital, revealed a perforated appendix and a rupture of a large, encysted, sero-purulent collection into the general peritoneal cavity.

If this case be taken as a type, and the period of time from the administration of opium to the final catastrophe be lengthened from the second to the fifth day, a large number of the cases formerly treated would be included in its class.

In the heretofore indifferent position of the profession towards this disease, the cases which were more or less acute in the commencement, but which became subacute in a few hours, were next gravest in character. These are cases in which the opium treatment is not necessarily to blame for allaying the anxiety that would naturally be felt by the practitioner when the gravity of the conditions present was fully recognized. They are rather cases in which necrotic changes in the mucous membrane follow a simple endo-appendicitis. Infection of the sub-mucosa takes place, and a renewal of the symptoms depends upon the supervention of a parietal appendicitis, either serous or suppurative. Involvement of the peritoneum (the peritoneal stage of Talamon), or the occurrence of a septic thrombosis and gangrene of the organ follows. The following case is a good example of such a condition of affairs :

J. L., a Swede, was admitted to St. Mary's Hospital with a history of having been suddenly attacked with severe abdominal pain, while lifting a heavy cake of ice, forty-eight hours previously. He had taken a cathartic for the relief of the pain; no other medicine had been administered, Dr. F. E. Wilson was finally summoned, and found the patient sitting up. He complained of pain in the right iliac region. The pain was not severe, nor did the pulse (96) and temperature (100° F.) indicate a severe grade of the disease. He was ordered to go to bed until the arrival of the ambulance. This injunction he did not obey, and the ambulance surgeon found him sitting in a chair. His friends said he had been up and down stairs several times during the day.

He was made ready for operation immediately after his arrival at the hospital. The usual right lateral incision revealed sero-purulent fluid free in the peritoneal cavity; very scanty adhesions were present. Septic peritonitis was already under way; an appendix perforated at about three-eighths of an inch from the tip, and gangrenous for about one-fifth of its length, was removed.[1] The patient died

[1] See Plate I, Fig. 1.

from the septic peritonitis which was present at the time of the operation.

The striking feature about this case was either the absence of symptoms proportionate to the gravity of the conditions present, or the indifference of the patient to the pain that one would naturally expect to be present in such a case. This form of the disease is calculated to cause the physician to hesitate in the diagnosis, and much valuable time is therefore lost.

Talamon has asserted that this subacute form of the disease corresponds most frequently with the class of cases in which the inflammation occurs in an appendix not covered posteriorly with peritoneum, and in which, therefore, perforation may occur into the retro-cecal connective tissue outside the peritoneum. The unfavorable prognosis in this class of cases is due, in his opinion, to the extra-peritoneal suppuration, which, without any obstacle to its advance, infiltrates the neighboring muscles and tissues, and provokes formidable and fatal complications. While I am willing to admit the dangerous character of this, as well as of any other form of the disease, in my experience the cases which become subacute after having been acute, as well as the cases which have been subacute from the commencement, and in addition those in which "cures" are attempted by the use of opium, are all equally and exceedingly dangerous. As an example of the latter class the following case, in which some particularly sad features were present, may be cited:

W. R., a medical student, was suddenly attacked with pain in the abdomen, referred to the right iliac region. A chill accompanied the attack, and vomiting followed it. The temperature was 101° F., and the pulse 98. The young man himself made the diagnosis of appendicitis, and a neighboring practitioner was summoned by the family. This practitioner succeeded in shaking the young student's confidence in his own diagnosis, and the patient was given as treatment three grains of morphine and ten grains of calomel daily. He seemed to improve, but on the sixth day another attack occurred. From this he again improved under a continuation of the same treatment. On the eighth day another advent of acute pain was followed by collapse. He was seen by Dr. R. W. Sharp, who confirmed the young man's original diagnosis, and afterwards by Dr. Delatour. He

was carefully removed to the Methodist Episcopal Hospital for operation, but his condition never improved sufficiently to warrant it.

In my judgment, the only cases treated non-operatively in which the prognosis can be said to be favorable are those in which the disease is neither progressive nor stationary, but, on the contrary, is retrogressive within the first twenty-four hours after the attack, as evinced by the symptom of tenderness—providing this latter has not been masked by the administration of opium or some of its derivatives. If, on the one hand, these indications are fulfilled, the attendant may encourage the patient that he will recover without operation; but, on the other hand, both will lean upon a broken reed, if reliance is placed upon any or all of the other symptoms. To sum up the whole matter, therefore, the prognosis, in cases in which no operative interference is instituted, is always uncertain; particularly so in cases in which the first symptoms subside and recur, as well as in cases which are subacute from their commencement.

The mode of termination may be: (1) By perforation, prior to the formation of proper adhesions, and thus giving rise to septic peritonitis; (2) infection of the peritoneum through the lymphatics or other channels of infection. In these cases the serous effusion may be (*a*) encysted, and subsequently become purulent; or (*b*) non-encysted, and occupy the general peritoneal cavity. In either case suppurative changes may occur. In the case of the encysted variety, a secondary rupture of this will lead to a rapidly fatal general septic peritonitis. (3) The rupture of an appendicular abscess, and consequent peritonitis. (4) Septic complications, arising from extension to and infection of the post-peritoneal connective tissue. (5) Gangrenous inflammation of the appendix, of the adhesions which surround it, and of the neighboring parts, including the blood-vessels, giving rise in the latter case to fatal hemorrhage. (6) Pylephlebitis, hepatic abscesses with their sequelæ (purulent pleuritis from extension, pneumonia, etc.). (7) The purulent accumulation may open into the cecum, rectum or bladder, and the patient perish from septo-pyemia, due to repeated infection of the original abscess cavity from these sources.

The mode of death may be from shock and collapse, as happens occasionally in cases of sudden primary perforation (perforation of the appendix without pre-existing adhesions). This condition supervenes, however, much more frequently in secondary perforation (rupture of appendical abscess, or encysted sero-purulent deposit). Septic peritonitis will destroy life by the combined effects of its own septic products, and a stercoremia, resulting from the intestinal paresis which follows in its wake. The effects of these septic products are most pronounced upon the circulatory organs, as evinced by the paralysis of the inhibitory cardiac nerve apparatus. Complications and sequelæ both of the disease and of the operative procedure will bring about a fatal result by methods peculiar to themselves.

The prognosis in cases subjected to operative interference will vary with the stage of the case at which the operation is undertaken, with the conditions found when the abdominal cavity is opened, and with the skill of the operator both in the manipulative technique and in the judicious employment of antiseptic or aseptic measures. There are some unfortunate sequelæ of laparotomies for appendicitis as well as for other conditions requiring the opening of the peritoneal cavity, which will be referred to later on.

All of the conditions heretofore mentioned that bring about a fatal termination may produce death after surgical interference, provided they were present before it. In other words, the operation will fail to rescue those already doomed by the existence of septic peritonitis, or septo-pyemic general infection.

The prognosis after operation in the chronic relapsing cases is generally good. In twelve cases operated upon by Bull[1] one proved fatal. In sixty-four cases collected by the same writer, occurring in the practice of other surgeons, not a single death is recorded. Kümmel[2] reports twelve operations, and no deaths.[3] Quénu[4] reports four additional cases operated upon by himself,

[1] Medical Record, New York, March, 1893.

[2] Archiv für klinische Chirurgie, Vol. LIII, Parts 3 and 4.

[3] Seven of Kümmel's cases and one of Quénu's are included in Bull's statistics.

[4] Bull. et Mem. de la Société de Chirurgie de Paris, Vol. XVIII, p. 397.

all of which recovered. To this are to be added twenty-four cases in my own hospital service, one of which proved fatal from a co-existing ulcerative enteritis.

The prognosis in cases of this type of the disease not operated upon cannot, in the absence of definite knowledge upon the subject, be definitely stated. Whether or not the appendix ever fully recovers itself after one or more relapses is a question which cannot yet be answered. In any case radical operation is more trustworthy than waiting for nature's uncertain methods, and therefore every patient who suffers from chronic relapsing appendicitis should be encouraged to submit to an appendicectomy.

With regard to the prognosis after the occurrence of one or more of the unfavorable conditions heretofore mentioned, it may be said in a general way, that the element of time will, as a rule, govern the fate of these cases. For instance, a perforation may occur, and yet the surgeon may luckily have succeeded in opening the peritoneal cavity before the escape of any of the contents of the tube. The following case will illustrate this point:

Miss M., aged twenty-two, a patient of Dr. Cruikshank, was placed by him under my care for operation, after a consultation of medical men had advised delay in the case. The usual right lateral incision revealed an appendix free in the abdominal cavity, absolutely without adhesions, swollen to the size of the little finger, and perforated in two places. The latter were minute openings, through which soft fecal matter oozed as the ligature was tightened about the base of the organ preliminary to its excision. The patient made a good recovery.

The prognosis after the supervention of the symptoms of peritonitis will vary according as the surgeon is permitted to interfere while the inflammation of the peritoneum is circumscribed or local on the one hand, or general on the other. With a strictly localized peritonitis, even though this enclose a considerable effusion which has undergone suppuration (encysted intraperitoneal focus of suppuration), the surgeon still has much in his favor, provided no unfortunate error in the technique permits

the septic material to contaminate the peritoneal cavity. The same may be said of appendical abscess. General peritonitis, without the occurrence of suppurative changes in its resultant serous affusion, may likewise permit a favorable termination. Even if suppurative changes have occurred in an effusion which is located in the general peritoneal cavity the case is not deemed necessarily hopeless by some surgeons, although the chances of recovery diminish progressively with the lapse of time since the infection of the fluid. The number of cases which recover under these circumstances must be exceedingly small as compared to those that perish. The effused serum forms a culture medium favorable to the development of bacteria, and in a few hours it may be transformed from an innocent serous fluid to a virulent toxic material giving rise to a rapid and general infection, before the occurrence of any suppurative changes whatever.

Undoubtedly, under these circumstances, the operative procedure, while it gives the patient the only chance of recovery, tends to hasten the end in cases that prove fatal. The general vital resistance to infection is always lessened by the administration of an anesthetic. It is not an infrequent occurrence to have patients develop the most pronounced general septic symptoms in cases where the condition of the peritoneal cavity is such as to cause surprise that the general symptoms were not more pronounced prior to the operation. What would have happened a few hours later is brought about by the anesthetic and operative procedure. The justifiability of interference in many of these cases is not lessened by this possibility; the necessity for early interference is simply emphasized by it.

With an extravasation of pus, serum, or sero-purulent fluid in connection with fecal matter, revealed by the operative procedure, but one result can be expected. It is the rarest occurrence in all surgical practice to have a patient recover under these circumstances. A patient will occasionally leave the operating-room alive, if the surgeon is not too persistent in his efforts to cleanse the peritoneal cavity.

Certain untoward intra-peritoneal complications follow the operation in this as in other cases necessitating the opening of the

abdominal cavity. These occur in about the same proportion as in laparotomies in general. They consist in intestinal obstruction due to intestinal paresis, ileus, or angulation. The intestinal obstruction due to intestinal ballooning is an almost necessary accompaniment of septic peritonitis, although the possibility of its occurrence, exclusive of this, is to be borne in mind; the prognosis after this condition is once fully established is very unfavorable. I do not remember ever to have seen a patient recover under these circumstances; certainly not after its occurrence in the course of septic peritonitis from appendicitis.

Ileus or angulation, or both, may be present before operation. The latter condition is of more frequent occurrence, and may be due to the manner in which the adhesions form about the ileo-cecal valve. The gravity of the case will be necessarily increased by the occurrence of this accident.

The occurrence of angulation after the operation may be due to adhesions which form between the intestine and some adjoining serous surface that has either been abraded, or has been the site of a former adhesion, or a stump of ligated omentum. The last-named condition occurred in one of my cases.

CHAPTER XI.

The Treatment of Appendicitis.—General Considerations.

While the physician is very generally first summoned to a patient suffering from appendicitis, the responsibility of the treatment should be shared both by the physician and by the surgeon. The great majority of cases should be treated surgically. Beyond the careful use of salines in the very commencement of the disease, and this only if the symptoms denote a mild type of the affection, the less medical treatment which cases of appendicitis receive the better. Above all things the use of opium must be avoided prior to making the diagnosis as much as possible. Its use masks the progressive character of some of the most important symptoms; with free use of the drug the patient's condition seemingly improves, but a sudden increase of pain, followed by distention of the abdomen, accompanied or followed by a rapid pulse and some rise of temperature, announce the occurrence of septic peritonitis. It should not be forgotten that an exceptionally virulent infection may produce septic peritonitis with neither primary perforation of the appendix into the peritoneal cavity nor rupture of an abscess cavity; delay in operative interference in such cases will certainly result in disaster, and interference may fail to save the patient.

The indications for operative interference during an attack of appendicitis may be summed up in a few words: As soon as the diagnosis of progressive appendicitis is assured, the abdominal cavity should be opened and the appendix removed. If opium has been injudiciously administered, and the progressive character of the case in hand is doubtful, it is better to err upon the side of safety, and remove the appendix at once. The conditions present are usually beyond the power of nature to remedy, while, in the hands of a surgeon who pays strict attention to aseptic

details both preliminary to and in the course of the operation, the latter entails less risk to life than that which is involved in even a mild attack of appendicitis which remains stationary at the end of twenty-four hours, with all its possibilities of lymphangitis, infection of the peritoneal cavity, retained muco-pus within the tube, and rupture of the latter into an unprotected peritoneal cavity; or ulceration and perforation either from the presence of so-called coproliths or inspissated fecal matter imprisoned by constriction within the cavity of the appendix, or from gangrenous conditions alone.

In formulating a definite rule for action in the operative treatment of appendicitis many difficulties are met with. To operate too early may be to operate unnecessarily, but this is always preferable to operating too late and hence unsuccessfully. The fact that operative procedures are quite safely performed where a distinctly outlined and encapsulated abscess cavity is present, provided the surgeon does not disturb its wall, has led Reclus and Schmit, of Versailles,[1] to adopt this period as the stage of election. These surgeons content themselves with simply emptying the pus-cavity. On the other hand, many surgeons advocate operation as soon as the diagnosis of appendicitis is made, whatever its grade of severity. A case demanding operation inside of twenty-four hours from the commencement of the attack is exceptional; but a case which is not practically well at the end of that time should be made the subject of operative interference. The surgeon, however, should by no means limit himself to that period. In cases in which unusually severe symptoms, such as high temperatures and a succession of rigors, are conjoined with exquisite tenderness in the right iliac fossa and an anxious facial expression, the surgeon should not hesitate to give the patient the benefit of an early and radical operation.

Where the patient is not seen by the surgeon until the third, fourth, or fifth day of the attack, the question as to whether or not the operative procedure may be contraindicated by the impossibility of removing the appendix without breaking down the

[1] Discussion upon appendicitis before the Surgical Society of Paris. Bull. et Mem. de la Société de Chirurgie de Paris, Vol. XVIII.

adhesive barrier which has been thrown out is one which is frequently encountered by those engaged in this class of work. As very tersely stated by Richardson,[1] we may be confronted by cases which are in such a condition as to be too late for the early operation, and too early for a safe late operation. In deciding this question, much will depend upon the experience of the operator, and the facilities which he may possess in the shape of skilled assistance and other requisites to meet all emergencies as they arise. With a thoroughly trained first assistant to stand opposite to the operator, and who with thick gauze compresses, wet with a $\frac{1}{1000}$ sublimate solution, is able to keep the field of operation well isolated from the rest of the peritoneal cavity, as well as the small intestines out of the way, the operation at this the period of localized peritonitis, with or without encysted seropurulent collections, is both safe and advisable. It will be almost next to impossible to avoid breaking down some of the adhesions, but with care on the part of the operator and a perfectly trustworthy assistant, removal of the appendix may be accomplished without undue risk of infecting the general peritoneal cavity, even under these circumstances, particularly where the collection lies dextrad of the ascending colon.

In some cases it may be possible to remove that portion of the appendix which is the seat of ulceration, perforation, or gangrene without being able to safely isolate and excise the remainder. Under these circumstances the portion accessible may be ligated and removed, the patient being advised to submit to a subsequent operation for the removal of that which must, in the patient's best interests, be necessarily left.

If the surgeon is called in after peritonitis has developed, operative measures may still be instituted, although the chances of recovery under these circumstances are relatively small. Infection of effused serum following peritonitis, not necessarily suppurative, offers just sufficiently encouraging results to impel the surgeon to offer the patient the benefit of a late interference. The case is almost necessarily hopeless after general suppurative peritonitis has commenced; the chances of recovery progressively diminish

[1] The American Journal of the Medical Sciences, January, 1894, page 13.

with the lapse of time following the beginning of the peritonitis.

If the septic peritonitis is due to the rupture into the peritoneal cavity of one or more of the minute embolic abscesses which sometimes form in the wall of the appendix in the course of a suppurative inflammation of the walls of the organ, an operative procedure may still be undertaken, provided the serous effusion is not large nor present sufficiently long to give rise to septicemia.

If the entire contents of an abscess cavity, or of an intraperitoneal encysted serous effusion which has undergone suppurative changes, have been discharged into the cavity of the peritoneum, the surgeon will be confronted by a condition of affairs which may well cause him to hesitate. In such cases it is advised by some to flush out the peritoneal cavity with sterilized water, or with an artificial plasma, with the view of ridding the patient of the source of the general infection which almost necessarily comes on under such circumstances. The operator, however, will be guided to a great extent by the condition of the patient. In my own experience I have never seen this procedure result in benefit when attempted; usually the patient's condition was such as to impel me to abstain from the effort, or to very quickly abandon it. It is usually impossible to follow the septic fluid, pus and fecal matter in those cases in which the appendix sloughs away from the cecum, and leaves a perforation communicating directly with the intestinal tract. The operator will be compelled, as a rule, to content himself with cleansing that portion of the peritoneal cavity which can readily be reached, and afford drainage by means of antiseptic gauze.

Certain cases may require a lumbar incision; those, for instance, which have resulted in a lumbar phlegmon. Here the indications are clear: The area of suppuration should be freely incised, and access afforded to its deepest point. The question of draining localized sero-purulent collections through the rectum or through the vagina rather than through the otherwise unaffected peritoneal cavity, is one requiring careful consideration. The difficulties experienced when either of these routes are

chosen introduce dangers into the case which outweigh those following the adoption of the intra-peritoneal route. I am not prepared to say, however, that I would decline to adopt such a course as that above indicated, in an individual case, in which a fluctuating tumor could be plainly made out from the direction of one of the cavities mentioned, and in which it was sufficiently certain that the intervening structures were so matted together by the inflammatory process as to afford a reasonable guarantee against connective-tissue extravasation or infection, or both, by means of the contents of the abscess. In other words, unless the latter is clearly pointing in one or another of the directions mentioned, drainage by one of these routes is unsatisfactory, to say the least, and not to be chosen.

In those instances in which the presence of a true appendical abscess can be made out, the purulent collection having taken place in the post-peritoneal connective tissue, and bounded an-

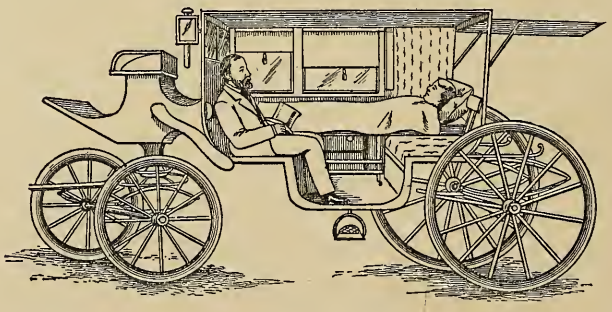

FIG. 14.—Invalid coach with rubber tires to the wheels, and a door opening behind through which the patient may be passed on a stretcher. Designed by Dr. MacNaughton. The side of the coach is represented as having been removed, in order to show the arrangement of the interior.

teriorly by the transversalis fascia and posteriorly by the iliac fascia, the abscess cavity may be reached by a horizontal or an oblique incision placed to the outer side of the epigastric artery. The skin, superficial fascia, aponeurosis of the external oblique, the transversalis muscle and transversalis fascia are successively divided. By this means the focus of suppuration is reached without incising the peritoneum.

The operation chosen should be carried out with the most rigid attention to aseptic surroundings and conditions, even though infection of the peritoneal cavity is known to have already taken place, or though suppuration be present. There can be no excuse for any failure in the aseptic technique, even under such circumstances. Unless asepsis can be satisfactorily secured at the patient's home, it will be better to transfer him to some hospital well equipped for the work than to attempt any make-shifts. With the invalid's coach, devised by Dr. MacNaughton, this can be accomplished in a perfectly safe and satisfactory manner. (Figs. 14 and 15.)

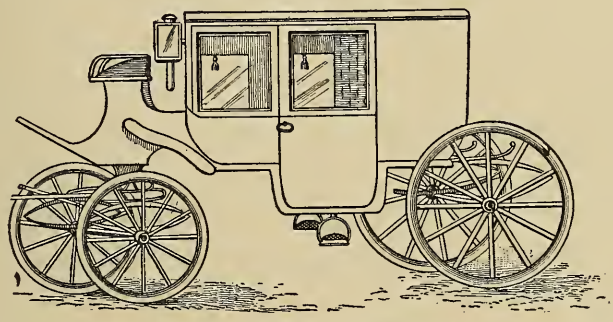

FIG. 15.—Coach closed and ready for the transportation of the patient.

CHAPTER XII.

The Operative Treatment of Appendicitis.

Inasmuch as, in a large number of cases, it will be necessary to carry out the operative procedure at the patient's own residence, this being particularly true for localities removed from cities or large towns, and in places where properly-equipped hospitals are not at hand, a systematic description of the steps to be taken as soon as the decision to operate has been arrived at will be useful.

A review of the patient's surroundings will be first in order. A room upon the same floor as that in which the patient is already lying should be selected, and due consideration given to questions of light and heat. Whenever possible, all of the necessary preparations should be made beyond the patient's sight and hearing; it does not add to the patient's confidence in the result by permitting him to realize how many and various are the precautionary steps to be taken before the risks of the operative procedure itself are entered upon.

The Preparation of the Room.—This portion of the work may be assigned to the nurse, who is to take charge of the case, for supervision, or to some member of the family, or a friend who has sufficient composure to comprehend the necessity for the preparation as well as intelligence to carry out the directions given.

The most suitable apartment being selected, the first step is to remove everything portable from the room, except the carpet. It will generally be easier to disinfect the latter by thoroughly wetting it with a solution of corrosive sublimate than to disinfect the bare floor with its cracks, containing, perhaps, the accumulated dust of several generations. The carpet should be thoroughly *soaked*, not simply moistened. Several gallons of the solution will be required in an average-sized room,

and the carpet should be so wet that the water oozes from the latter, when it is walked upon, as water is forced from a wetted sponge when it is squeezed. The edges of the carpet should be particularly looked to, for it is here that dust is apt to accumulate.

The first wetting of the carpet should be done as soon as the furniture, pictures from the walls, mantel ornaments, curtains, hangings, etc., have been removed. It should be wetted again just before the operation. Following the wetting of the carpet, the ceiling, cornices, picture-mouldings, door- and window-casings, and chandeliers should receive attention. These should all be thoroughly wiped with a cloth wetted with the corrosive sublimate solution. If there are any closets opening into the room they should be emptied of their contents, and the doors closed and sealed by caulking all cracks with common cotton, plugging the key-hole with the same. Strips of paper may be pasted over these in addition. If the chandelier is of the ornate variety in use a decade or so ago, and made in patterns of vines, flowers, and leaves, it will be almost impossible to thoroughly disinfect this. A sheet, wrung out of the corrosive sublimate solution, may be wrapped about or made to enclose the chandelier like a bag, holes being cut for the passage of the burners, in case these are needed, either for the furnishing of light or the use of the gas-stove.

The surgeon has now to consider what furniture will be absolutely necessary for the purposes of the operation. Anything that can be dispensed with in making up the list of articles should be stricken off. The first thing to be considered is the operating table. The one figured at page 128, and which I employ in my hospital work, unfortunately is made of iron, and is too heavy for transportation and use in private practice. There is a portable table, designed by Forster (Fig. 15), which combines lightness and compactness when folded, and hence is easy of transportation. The Trendelenburg attachment is easily manipulated. In the absence of any specially designed table, a new table, such as is sold by the dealers for kitchen or laundry purposes, should be procured. Nothing is more certain to defeat

the whole preparation thus far made, or to make it absolutely inconsistent, than to take a table from the kitchen, with all of its possibilities of infection, and attempt to use it for the purposes of the operation.

If the surgeon is finally compelled to use a table that has been previously in use, he should have it scrubbed thoroughly with hot water and soap previously to bringing it into the room prepared for the operation. When it is finally placed in the room, in order to make assurance doubly sure, the table is to be covered with a sheet, wrung out of a solution of corrosive sub-

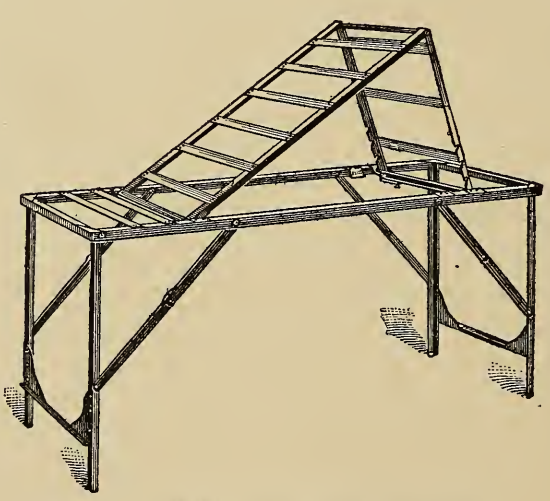

FIG. 16.—Forster's portable Trendelenburg table.

limate, and this so arranged as to completely cover the table, the edges of the sheet reaching to the floor, where they are tacked. If a single sheet is not sufficiently large for the purpose, two or more may be used.

The table is covered with a folded blanket. This should be procured new if possible. It is safer to use this than one that has been in domestic use. When properly folded and placed upon the table, the blanket is to be covered by a sheet from the laundry, and the corners simply pinned about the table. As a rule, a pillow can be dispensed with, and, following the rule already laid down, should be omitted.

In order to obtain the advantages of the Trendelenburg position in cases in which this is indicated, Dr. Florian Krug, of New York, has devised a portable frame to be used in connection with a common table. This position is not all essential in any case, and, under the conditions of most of the cases operated upon in the height of the attack, is positively contraindicated (see pages 153, 160).

Proper provision is now to be made for conveniently placing the instruments, dressings, and other requisites to a properly-conducted aseptic or antiseptic operation. At least two small

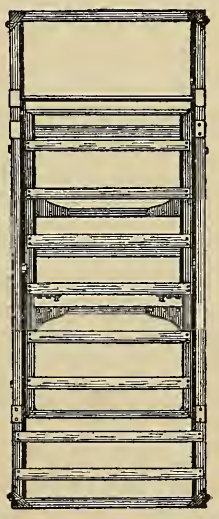

FIG. 17.—Forster's table folded for transportation.

tables will be required. These may also be such common tables as can be procured at a trifling cost, and should be perfectly new, if possible. If those already in use are used they should be cleansed, and the same safeguards placed around them as in the case of the operating table, except that the sheets covering them need not be tacked to the floor, but pinned closely around the top and legs. The mantel-shelf of the room may be utilized for the anesthetizer's outfit, if but two tables can be obtained.

In addition to the two smaller tables two or more of the common wooden-bottomed chairs, such as are used in the kitchen,

will be useful. These should be procured new, if possible; when this cannot be done, those used must be thoroughly cleansed and protected in a manner similar to the method employed in the case of the tables. These chairs will be found convenient for placing washbowls at convenient points, as well as for the gas-stove, alcohol-lamps, sterilizers, etc.

As a part of the preparation of the operating-room, it will be necessary to provide facilities for heating water, sterilizing instruments, compresses, and dressings. In the city almost every household has a gas-stove, or such can be obtained from the nearest hardware-store. A kerosene-stove will answer the purpose, but is not so cleanly. I very much prefer the larger alcohol-lamps or stoves, so generally used by picnic parties, and easily procured. In the country the kitchen-stove is always available.

It will also be necessary to provide at least four large washbasins. These may be of granite-ware, if these can be obtained; porcelain washbowls are next best. Metal basins unprotected by a glazing of porcelain, or similar covering, will be attacked by the corrosive sublimate solution. The combination formed, if the basin is made of tin plate (iron covered with a coating of tin), will not be of any particular harm, for the reason that the salts of tin are quite efficient antiseptics of themselves.

At least two irrigation-bags should be provided. The combination of hot-water bottle and douche, now made by the rubber companies, will be found very convenient. The family fountain-syringe is more than likely to be foul and unfit for the purpose. When it is possible to procure a brand-new douche-bag this should be done.

The Preparation of the Patient.—If the operation is performed in an interval of quiescence, and sufficient time can be had for a complete preparation of the patient, this should be done as follows: Upon the day preceding the operation the bowels are to be thoroughly moved, by means of sulphate of magnesium, in half-ounce doses, one or more of which may be given at intervals of from two to four hours. Following the administration of the cathartic no solid food should be allowed. A

simple diet of sterilized milk, or, at the most, thin broths or soups must suffice for the day preceding the operation. A full bath and inunction of vaseline tend to insure a healthy action of the skin, and add to the comfort of the patient.

The entire abdominal surface should be thoroughly scrubbed and shaved. This should include the pubic region and the genitals. Washing with a $\frac{1}{1000}$ corrosive sublimate solution should follow. A large compress of cheese-cloth or Turkish towelling material should be thoroughly wetted in a boro-salicylic solution (Thiersch's), consisting of fifteen grains of salicylic acid and ninety grains of boracic acid in a pint of water. This compress, sufficiently large to cover the abdominal and pelvic regions, both anteriorly and laterally, must be thick enough to retain a considerable amount of the solution. Twelve thicknesses of cheese-cloth, four of common towelling, or two of the Turkish towelling, will suffice. This is to be covered with a layer of oil-silk, and the whole held in place by means of a firm binder snugly pinned about the patient's body, and prevented from slipping by two perineal straps. The binder itself may be of Turkish-towel material.

In addition to the antiseptic properties of the boro-salicylic solution, it possesses the additional advantage of softening and assisting in the loosening of the layer of dead epithelium which is present in varying quantities upon the skin, even after a bath and vigorous scrubbing.

The dressing of boro-salicylic solution may be permitted to remain until the patient is etherized and brought to the operating table. It is then removed and the skin washed with ether to remove the loosened epithelial scales and whatever fatty matter remains. Filling the depression at the navel with collodion completes the preparation of the abdominal wall.

Upon the morning of the operation the patient is to have a simple enema; he should also absolutely abstain from food for six hours, and from drink for at least two hours before the operation. Unless some direct indication is present for its employment, no stimulants are to be given at this time, for the reason that they increase the tendency to vomit under the anesthetic.

Where the operation must be proceeded with without delay, and there is not sufficient time to properly prepare the patient, cleansing and shaving the abdominal wall just prior to the operation must suffice. It may then be covered with a towel, wrung out of the solution of corrosive sublimate, pending the remainder of the preparation. When the patient is placed upon the table, I have been in the habit, in emergency cases, of applying tincture of iodine over the parts immediately concerned in the operation, as an additional precaution.

The Instruments Required.—In selecting the instruments required it will be useful for the operator to rehearse the operation in his mind, and make out his list of instruments at the same time, in the order in which they are to be used. In this manner he will familiarize himself with the different steps of the procedure, and be more certain to have at hand just what will be required.

For the purposes of the anesthetizer a hypodermatic syringe and morphia and atropia tablets, a chloroform-mask and chloroform, an ether-inhaler and ether, and a tongue-forceps; whiskey for hypodermatic use poured out in a small glass should also be provided; nitrite of amyl, tablets of nitro-glycerin, and of strychnia, and a Faradic battery should also be at hand.

Next in order will come the instruments proper. These will include, following the order in which they will be required, a scalpel of medium size, twelve hemostatic forceps, two anatomical or dissecting forceps, scissors, both curved upon the flat and straight, retractors for the abdominal incision, a Keith's ligature-carrier, or Cleveland's modification of the same (Fig. 18), or an aneurism needle; the ligature-crutch for carrying the loop surrounding the appendix well down to its base, where this is not easily accessible (Fig. 19); the thermo-cautery; a large straight Hagedorn needle for applying nitric acid to the stump; six long sponge forceps for cleansing the abdominal cavity; full-curved fine needles for applying the Lembert suture; an Abbe's needle forceps, a most convenient instrument for intestinal work; larger curved needles for closing the abdominal wound; and a proper needle forceps for these latter.

The fingers alone can manage these needles best, as a rule. I have recently modified the Hagedorn needle so that they may be grasped by a flat-bladed forceps, such as a common hemostat, by having the portion at the eye-end twisted a quarter turn upon itself. This does not alter the shape of the opening in the skin which the Hagedorn needle makes, and in which resides the principal advantage in its use (Fig. 20).

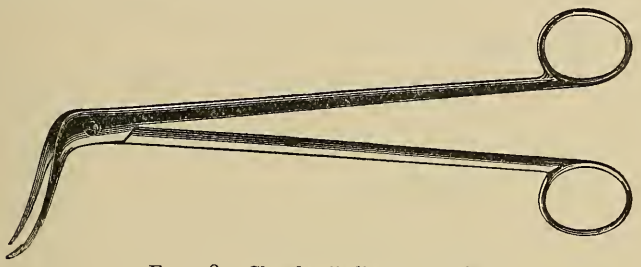

FIG. 18.—Cleveland's ligature carrier.

Ligature material should be of fine silk or catgut. The latter may be sterilized by boiling in alcohol if proper facilities are at hand for accomplishing this. If not, that prepared by immersing the catgut for a few hours, or over night, in equal parts of carbolic acid, glycerin, alcohol and water, and subsequently

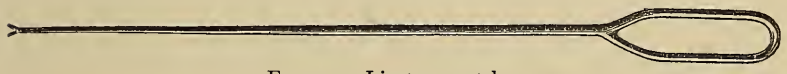

FIG. 19.—Ligature crutch.

transferring to alcohol for permanent preservation, is to be preferred. The silk used should be iron-dyed (Brainerd & Armstrong's make), and sterilized by boiling in a five-tenths of one-per-cent. solution of chloride of sodium for ten minutes. The sutures should be of crin-de-Florence or silkworm-gut; this may also be sterilized by boiling in the salt solution above mentioned.

Sponges and Dressing-Materials.—These are to be made of cheese-cloth exclusively. Pieces of this material of a single thickness, and eight inches square, when crumpled make a sponge or "tüpfe" for common use. A portion of cheese-cloth folded in a manner to make an eight-inch square, and from six to eight

thicknesses, makes a laparotomy sponge. A yard square of the cheese-cloth, when crumpled, makes a dressing for the wound; as many of these as required may be used. A "bat" of cotton-batting is used to cover the immediate dressings, and an abdominal binder to cover all, similar to that described in speaking of the preparation of the patient, is to be provided. Two dozen of the eight-inch squares or "tüpfe," a dozen of the laparotomy sponges or compresses, and a dozen of the yard squares should be provided.

The Sterilization of the Instruments.—At the present time aseptic precautionary measures have largely taken the place of antiseptic methods. It is the surgeon's bounden duty to prevent, in so far as in him lies, contamination by means of any article which he brings in contact with the patient. This holds true in cases already septic as well as in those aseptic. No one may know at just what point the fatal germ enters where a lethal exit terminates the case.

FIG. 20.—Modified Hagedorn needle.

Special means of accomplishing disinfection of the instruments and dressing-materials by heat are now numerous. These include apparatuses for dry-heat sterilization, and those employed for moist-heat or steam sterilization. The former involves a somewhat cumbersome and expensive apparatus, including double-walled asbestos-covered ovens, with thermometer and thermostat attachments. Even with these precise methods of regulating a certain degree of heat, the edges of cutting instrument are dulled by having their temper drawn. At least an hour's exposure is necessary for the sterilizing process, and even this, it is claimed, should be repeated (fractional sterilization).

Boiling the instruments in a one-half of one-per-cent. solution of the alkaline carbonate of soda answers the purpose for all but sharp-edged instruments. These latter, however, have their

edges roughened by the action of the alkali upon the delicately thin metal.

During the past year I have been in the habit of sterilizing all instruments by boiling them for three minutes in a solution of the sapo viridis of the Pharmacopeia. A level teaspoonful of the green soap, dissolved in two quarts of water, is placed in an asparagus or fish boiler (Fig. 21), or other receptacle, and the

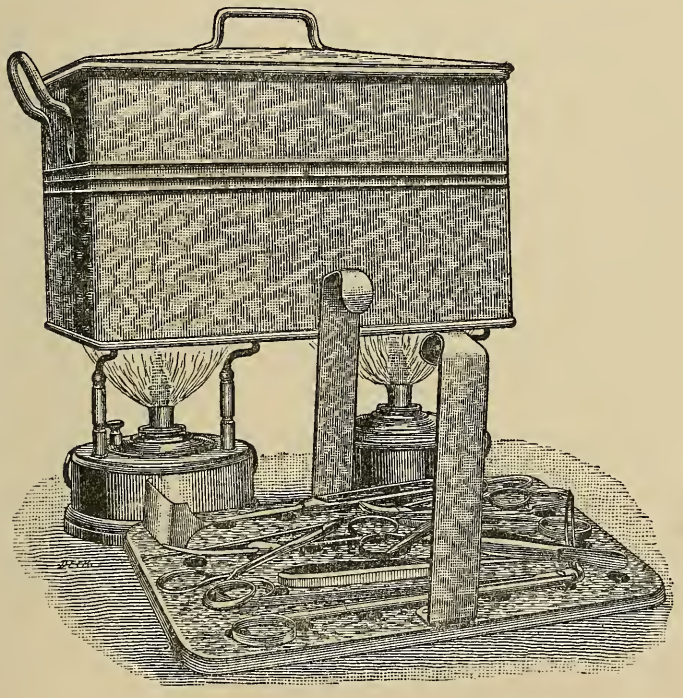

FIG. 21.—Asparagus boiler, for sterilizing purposes.

instruments placed therein. The length of time required is only three minutes from the time the solution commences to boil, and the most delicate-edged instruments are not impaired in the slightest by this method of sterilization. The movable tray, with which these boilers are provided, is a great convenience in removing the instruments from the solution. They are now made of glazed or so-called agate-ware, and are most convenient and efficient for the purpose.

Upon being removed from the boiler the instruments are placed, if the case is such as not to require the employment of antiseptic agents, upon a sterilized towel and covered by another towel. An additional precaution, and one which I have been more recently in the habit of taking, is to place the instruments in a three-per-cent. solution of carbolic acid, in open trays. Ordinary domestic pie-baking dishes answer the purpose. If the surgeon elects to provide himself with special convenience for this class of work, he may procure from the dealers a set of hard-rubber trays made for this purpose. A bowl of sterilized water, or a three-per-cent. carbolic solution, should be placed upon the table beside the instruments to rinse off the latter as they are returned from the operator, and before replacing them in the tray.

The Sterilization of Dressing and Sponge Materials.—This can be accomplished in as simple and entirely satisfactory a manner as the process for the sterilization of instruments just detailed. After the instruments are removed from the boiler and placed in the three-per-cent. carbolic solution, the former is utilized, after emptying it of the green soap solution, for the sterilization of the gauze or cheese-cloth material for the tüpfe, dressings, laparatomy sponges, etc. These should be packed in the boiler in such order as will permit of their removal as they are required. Those articles which are to be used last should be placed in the bottom, and so on; unnecessary handling will thus be avoided. The silk is wound upon glass bobbins or spools, and is boiled with the gauze; the silk-worm gut is also boiled in the salt solution.

A one-half-per-cent. solution of common salt is now poured over the contents of the boiler. A teaspoonful of the salt to a pint of water is near enough to the strength of the solution mentioned for all practical purposes, and boiling for ten minutes is sufficient for complete sterilization. The silk and silk-worm gut are removed and placed in the carbolic solution; the remainder of the contents of the boiler are removed as they are required in the course of the operation.

Articles to be Steam-Sterilized.—The sterilization of the

operating gowns, linen caps for covering the head, the cotton batting and binder, as well as the rubber aprons, is accomplished by the use of the Arnold's steam-sterilizer, now so commonly used for milk sterilization. The binder, being the last to be used of the articles steam-sterilized, is placed upon a folded towel in the bottom of the sterilizer. Upon this is placed a roll of cotton batting and over this another towel is placed. The linen caps for covering the head of the operator and the assistants come next in order and then the operating gowns. A dozen towels are next placed in the sterilizer and then the water-proof aprons, previously washed in a corrosive sublimate solution, are placed on top of all.

These water-proof aprons are best made of double-faced rubber, in order that they may be more thoroughly cleansed. They are cut in such a shape as to reach from the upper portion of the chest to the floor, and provision made for fastening this upon the person by proper tapes, or pieces of rubber tubing fastened to the apron by means of safety-pins.

One-half hour's steam sterilization is required for these articles. The surgeon will do well, therefore, in order to avoid unnecessary delay, to commence his preparation by packing the steam-sterilizer and starting this part of the preliminary work in advance of the rest.

The Disinfection of the Surgeon and his Assistants.—The surgeon and his assistants should make every possible endeavor to produce the most perfect cleanliness in every respect about their own hands, arms, beard, hair, etc., and to exercise a strict conscientiousness in maintaining the same. Those who are to handle instruments, sponges, or dressings, and who are to come in contact in any way with the field of operation should scrub their hands and arms vigorously with green soap and warm water, for at least five minutes, after which these parts are immersed in a $\frac{1}{1000}$ corrosive sublimate solution for another five minutes. The finger-nails should be trimmed prior to the scrubbing, and especial care given to their cleansing. During the operation there should be conveniently placed a bowl of corrosive sublimate solution in water for rinsing the hands, and

another bowl containing a solution of the same in alcohol for rinsing and getting rid of the sticky feeling which results from contact with blood.

If the surgeon has been in the habit of carrying on aseptic work, he will have sacrificed his beard to the requirements of absolute and typical technique in this respect. If he wears a beard, he must wash this very thoroughly and disinfect it with a corrosive sublimate solution. In addition to this he will wear a properly-constructed hood, which will cover the beard upon his face as well as the hair upon his head.

The patient is anesthetized upon his own bed, and then carried to the room which has been prepared for the operation. As little of the bed-clothing should be brought with him as possible, and this should be removed and taken out of the operating room at once. If sufficient time has been available for the purpose of a preliminary cleansing of the parts these should now be exposed and subjected to the final washing with ether. Scrubbing and shaving after the patient is under the anesthetic is always to be avoided when possible. The field of operation is to be well isolated by the liberal use of sterilized sheets and towels covering the remainder of the patient's body.

The Trendelenburg position is best adapted for the removal of the appendix, provided no septic fluid surrounds the latter. In case an encysted sero-purulent deposit or an appendicular abscess is present, this position has the disadvantage of favoring the passage of the pus to the upper portion of the peritoneal cavity, and at the same time of preventing the rapid turning of the patient upon his right side in order to obtain the assistance of gravity in preventing the infection of the peritoneal cavity. For operations performed between the attacks, as well as during the first few hours of an attack, it is greatly to be preferred.

The dorsal position should be first employed in all doubtful cases which are operated upon in the uncertain intermediate stage. If it is found upon reaching the appendix that neither sero-purulent nor purulent material is present, the patient may be brought to the Trendelenburg position for the remainder of the procedure. This may be readily accomplished if a proper table

is employed, which permits an easy and rapid change from one position to another. In order to facilitate the turning of the patient to either side, and at the same time to enable the operator to obtain the advantages of the Trendelenburg position when this can be employed, I have had a table constructed, shown in Figs. 22, 23, and 24. A reference to the cuts will explain its mechanism without further description. If a tumor is felt, it is fair to assume that septic fluid is present, and the dorsal position must be used, with facilities for turning the patient over on the right side at a moment's warning.

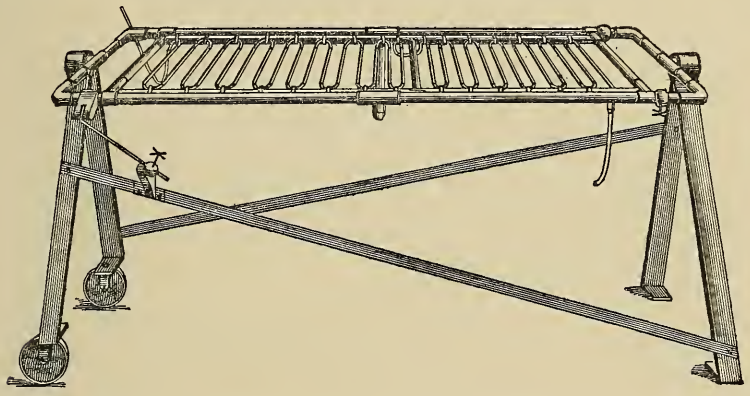

FIG. 22.—Operating table, with steam or hot-water coil attachment for heating. The bed of the table swings upon trunnions at either end, and is secured in position by a simple device.[1]

The position and direction of the incision are to be selected in accordance with the conditions present and the purpose of the operator. If the case is one in which the surgeon will probably undertake to remove the appendix, the vertical incision, passing along the dextral edge of the right rectus muscle, may be chosen. (Fig. 26.) If a tumor be present, and the object of the operator is simply to evacuate an abscess, an incision, following the general direction of the fibres of the external oblique muscle over the most prominent portion of the tumor, will be better. In case the diagnosis is doubtful, and the operation is, to a great

[1] I am indebted to Dr. Bristow for valuable assistance and suggestions in the construction of this operating table.

extent, an exploratory one, the median incision is to be selected. Another method of gaining access to the parts, which I have latterly employed in both classes of cases, is through the oblique incision. (Fig. 27.)

The vertical incision gives the best access to the underlying parts, and permits a ready exploration, as well as ease of excision of the appendix. A disadvantage of its employment, however, consists in the frequency with which the operator injures the afferent branches of the deep epigastric vein, which accompany the artery within the sheath of the rectus muscle. The artery can easily be avoided, but the veins that empty

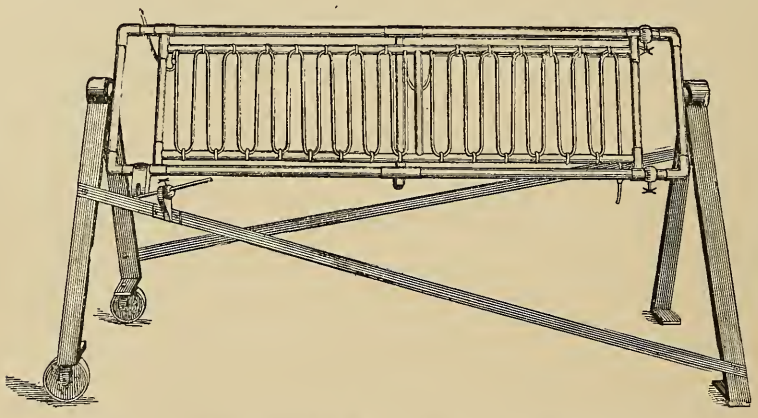

FIG. 23.—Operating table tilted to one side to facilitate emptying of an abscess cavity or an encysted intra-peritoneal sero-purulent collection.

into the epigastric vein or veins, for there are sometimes two, are quite large, and pass almost at right angles to the incision. Again, in suturing the wound, if the sutures are properly placed, and include the muscular structure, the trunk of the vein may be punctured by the needle. This is sometimes the cause of vexatious delay during the completion of the operation.

The oblique incision is not open to the above objection, but its employment necessitates somewhat more retraction of the inner edge of the incision if the caput coli does not come readily into view. This disadvantage can be overcome by the aid of a competent assistant, although where there is much tension of the abdominal muscles it keeps both his hands constantly in use for

this purpose. While abdominal retractors have their proper sphere, there is nothing that can compare in this operation with the fingers of an intelligent co-worker.

To facilitate the search for the collection of sero-purulent matter or pus which, when intra-peritoneal, in the majority of cases is to be sought between the caput coli and the lateral pelvic wall, an additional incision may be made extending from the middle of the oblique incision downward and outward at right angles to the former. (B, Fig. 27.) To facilitate exploration in an upward and inward direction an additional incision may be made from the cephalic limit of the oblique incision, in a direction

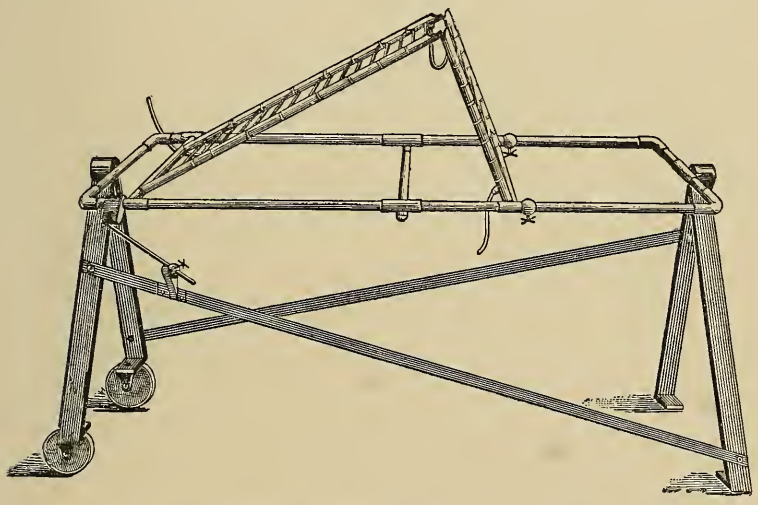

FIG. 24.—Operating table in the Trendelenburg position.

upward and inward to the dextral edge of the right rectus muscle. (C, Fig. 27.) These two additional incisions, while they will cross the fibres of the external oblique muscle, will run parallel with the fibres of the internal oblique muscle. The additional incision first described, which extends from the middle of the oblique incision toward the anterior superior spinous process of the ilium, has the advantage of facilitating drainage in certain cases, and of permitting suturing the entire incision exclusive of this. Subsequent ventral hernia is avoided in those cases in which it is most apt to occur, namely, suppurating cases

in which the abdominal wound cannot at once be closed. This portion of the oblique "T" incision, even if it unites only by secondary intention, is the least likely to give rise to ventral hernia of any of the incisions in the abdominal wall that are employed in appendicitis cases.

Where the oblique incision is employed, the cut through the skin is made in the direction shown in Fig. 27. This, as will be observed, is not quite parallel with Poupart's ligament. The fibres of the external oblique muscle are exposed and separated at the outer and upper limit of the oblique incision. At the inner and lower extremity of the cut the white-looking and ten-

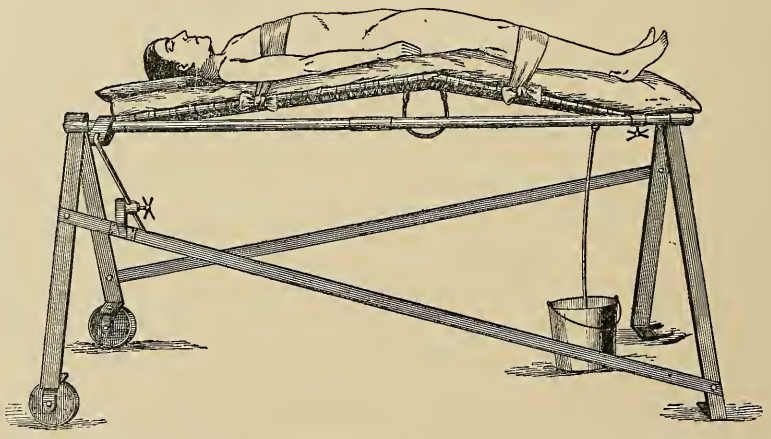

FIG. 25.—Showing patient secured to the table ready for tilting to one side. The slight elevation of the bed of the table brings the field of operation in a conveniently prominent position.

denous structure, known as the linea semilunaris, comes into view. After incising this structure the cut is extended in an upward and outward direction so as to divide some of the fibres of the internal oblique muscle. These will be cut squarely across. The fibres of the transversalis muscle, like those of the external oblique, are sufficiently near to being parallel with the portion of the incision corresponding to them in location as to permit of separation to some extent by blunt dissection. In any case, not much time is to be wasted in trying to avoid division of muscular structure, but the incision is to be carried directly down to the transversalis fascia.

As the incision deepens over the seat of the disease, if the latter is ventrally placed and advanced to the stage of suppuration, some edema of the abdominal wall, with or without matting together of its separate structures, will be observed. Where no suppuration is present, or where it is deeply placed dorsally or in the pelvis, this will not be seen. When present it will serve as a guide to any adhesions between the peri-appendicular structures and the abdominal wall, and will sometimes enable the operator to reach the interior of a sero-purulent or purulent collection without invading the peritoneal cavity at this stage of the operation.

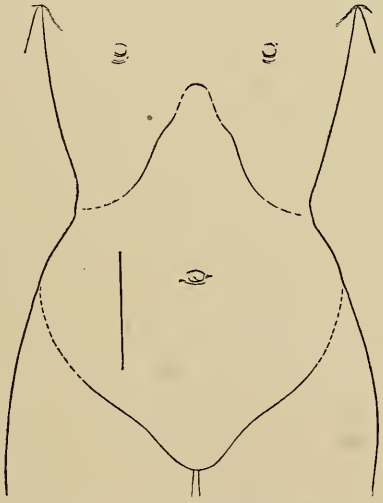

FIG. 26.—The vertical incision.

The transversalis fascia is now reached. This is a thin aponeurotic membrane, which lies between the inner surface of the transversalis muscle and the peritoneum. The operator picks up this with a pair of anatomical forceps, while the first assistant, who stands opposite, does likewise. The fascia is incised between two forceps, whereupon the operator, with a pair of anatomical forceps in each hand, proceeds to separate the layer of subperitoneal fat, which lies between the transversalis fascia and the peritoneal membrane. This will expose the latter, which will be

recognized by its very thin character, and by the upward and downward movements of the intestines beneath, if the visceral and parietal layers of the peritoneum are not attached to each other.

In grasping the peritoneum to incise it, care should be exercised to lift it as far anteriorly as possible, in order to avoid injury to the omentum or intestine beneath, when the cavity of the peritoneum is finally invaded. Of course, if adhesions exist at this

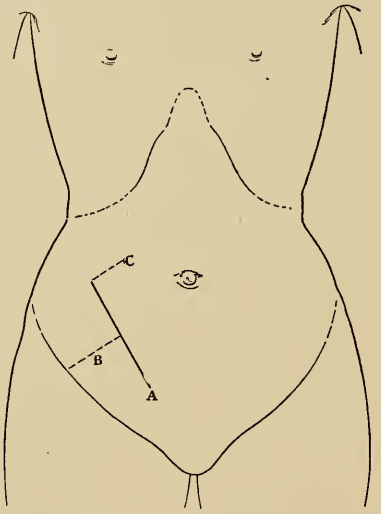

FIG. 27.—A, the oblique incision. The longer dotted line, B, employed for the purpose of facilitating drainage in cases in which it is deemed advisable to close the oblique incision, converts this into the oblique T incision. The shorter dotted line, C, is sometimes useful when further exploration is found necessary.

point, it will not be prudent, even if it were possible, to so lift it. The peritoneum being opened, the index finger is introduced through the opening, and upon this, acting as a guide, and a guard against injury to the intestine or omentum as well, the incision is extended in either direction to the required extent.

If no adhesions exist ventrally, the operator proceeds at once to expose the cecum by making any necessary addition to his original cut. Abdominal compresses, made of six or eight thicknesses of cheese-cloth, eight inches square, hemmed at the

edges to prevent fraying, and wet with a $\frac{1}{1000}$ solution of mercuric chlorid, are now introduced as far as possible upon all sides of the exposed diseased area in order to thoroughly isolate the remainder of the peritoneal cavity from the primary focus of infection. Everything is now in readiness to turn the patient over upon his right side at a second's warning. Adhesions are now gently parted, always commencing with those between the pelvic wall and the outer surface of the colon, if any exist at this point. The site of the disease is thus sought. Immediately upon the appearance of any sero-purulent material this is gently but rapidly wiped away, if small in amount; if the quantity be large, the patient is turned upon his right side, and there supported, while the fluid which flows out is gently washed away. The finger is now carefully introduced at the point between the adhesions from which the fluid made its first appearance, and further egress given to the latter. At the same time the operator ascertains whether the parts in the neighborhood are well walled off from the peritoneal cavity. If this is assured, he may venture to wash out the cavity directly with a gentle stream from the irrigating apparatus. For purposes of irrigation either Thiersch's boro-salicylic solution or a freshly-prepared solution of sodium chlorid, or of the normal salts of the blood, in sterilized water may be employed at this stage of the operation. Plain sterilized water will answer the purpose. When an abscess cavity is to be disinfected, however, a $\frac{1}{2000}$ solution of mercuric chlorid is to be used. This in its turn is to be washed away with one of the solutions just named. During the time that the patient is turned upon his side it is of the greatest importance that the first assistant attend strictly to the task of retracting with his hands the edges of the abdominal wound and of keeping the remainder of the peritoneal cavity isolated, as well as adjacent coils of intestine, when adhesions have been broken down, from falling into the septic area, by means of large and thick gauze compresses.

After the purulent material has ceased to flow, and the parts have been cleansed as well as the position will allow, the patient is replaced in the dorsal position, and the search for the

appendix is continued. The Trendelenburg position may now be employed to facilitate this stage of the operation, as well as to relieve the principal assistant. Watchfulness must be exercised for other sero-purulent deposits, and everything made ready for the right lateral position, should necessity demand it. Personally, I never feel perfectly comfortable with the patient in the Trendelenburg position, except in those cases in which I am operating very early in the disease, before any intra-peritoneal foci of suppuration are present, or very late, when an appendicular abscess exists. These latter are usually single, are walled off by strong adhesions, and present and empty themselves promptly upon opening the peritoneal cavity, after which the elevated pelvis (Trendelenburg's) position offers many advantages.

If the vermiform appendix does not come readily into view, or within reach of the operator, search for its site may be further facilitated by identifying the location of the cecum. This is done by means of the pouched appearance of the latter organ, as well as by the presence of the three flat, longitudinal, muscular bands, each about half an inch in width, which commence at the attachment of the appendix to the cecum. The ventral band, the largest of the three, will usually come into view, unless shut off by adhesions; the dorsal band is placed along the attached border of the intestine. The identification of either of these bands will serve as a guide to the appendix. The third or lateral band is placed upon the sinistral side of the ascending colon, and if adhesions are present, will not be available in the search.

As the adhesions are parted the appendix is identified. This will be found to be of a somewhat solid consistency, feeling not unlike a slightly flexed little finger. It is to be carefully freed from its surroundings by the finger of the operator, very much in the manner in which the Fallopian tube is isolated in the operation for pyosalpinx.

In the attempt to isolate the appendix the surgeon must not lose sight of the fact that he may do more harm than good if the organ is so placed as to form a portion of the protecting wall of adhesions; particularly if its position prove to be upward and inward, inward, or downward and inward (on the lines N. E., E.

or S. E., Fig. 8). On the other hand its isolation and removal from the positions downward, downward and outward, outward, upward and outward, and upward (S., S. W., W., N. W. and N.) will generally be found practicable and safe. If symptoms of intestinal obstruction have been present in the case, it will be best, even with the additional risk, to break up all adhesions with the view of relieving the obstruction, first being assured that thorough disinfection of the primary focus of sepsis has been accomplished.

The manner of dealing with the appendix will vary with the character of the case. In some instances its condition will not

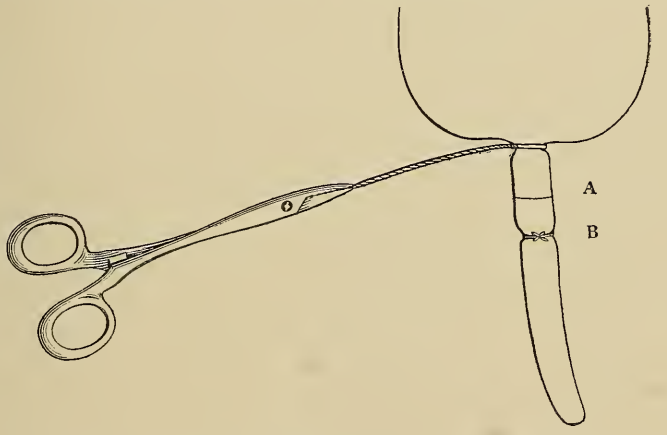

FIG. 28.—Temporary constricting ligature in position. A, Line of circular incision; B, second ligature applied to the appendix to prevent escape of its contents when the final amputation is accomplished.

admit of any choice. Simple ligature, by means of chromicized catgut at its base, or as near thereto as possible, the mesentery being included in a separate ligature, whenever practicable, and amputation of the organ, the mucous membrane being destroyed by means of the thermo-cautery or fuming nitric acid, is deemed quite sufficient by some surgeons. Indeed, it happens only too frequently that the exigencies of the case will only permit of this method, as in cases in which abscess or a sero-purulent fluid is present, and it is found impossible to gain room for the application of a typical procedure without running the risk of breaking

down limiting adhesions. The wall of the appendix, if in a gangrenous condition, will sometimes scarcely hold a ligature, much less permit of the application of a series of sutures in closing over the stump in some of the methods proposed. The application of a pair of clamp forceps or hemostats to the site of the base of the appendix must suffice in some instances. Even the adjoining wall of the cecum itself is frequently softened by inflammatory processes, and will not hold a suture. Again, the patient's condition will not admit of the delay necessary in these niceties of technique in many of the cases which fall into the surgeon's hands.

Where a rapid completion of the operation is not demanded,

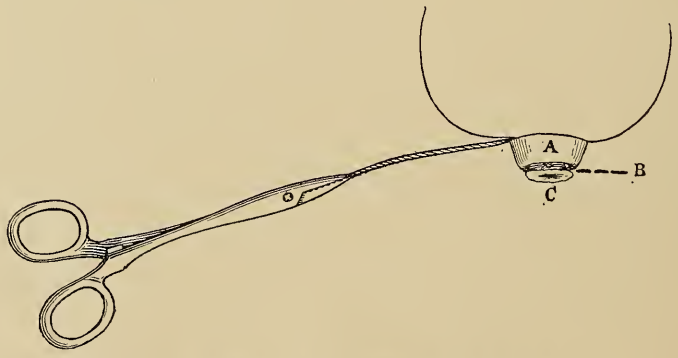

FIG. 29.—A, Cuff-shaped flap of serosa and subserous connective tissue; B, permanent ligature of the muscular wall and mucous lining of the appendix; C, mucous membrane remaining in stump.

and the condition of the parts will permit of it, the method which I have employed with very great satisfaction is that of the circular flap amputation. The employment of this procedure is almost entirely limited to cases of the recurrent and chronic relapsing varieties of the disease operated upon in intervals between the attacks. It is carried out as follows:

A temporary ligature is thrown around the base of the appendix close to the cecum. (Fig. 28.) This is not tied, but simply twisted until it constricts the organ sufficiently to prevent the escape of fecal matter from the cecum should the cavity

of the appendix be accidentally invaded before the application of the final and permanent ligature. This temporary ligature should be sufficiently long to be grasped by a pair of clamp-forceps at its extremity, which will aid in the twisting; at the same time it will, by its weight when dropped outside the wound in the abdominal wall, prevent the untwisting of the ligature. A second ligature is applied and tied about the appendix at a point half an inch distad of the first ligature. (B, Fig. 28.)

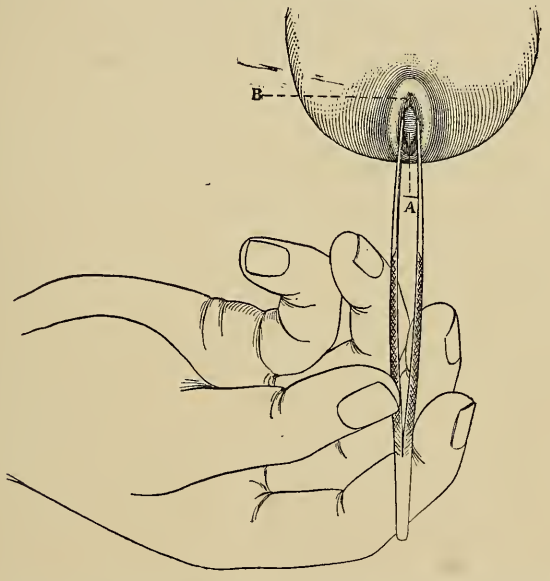

FIG. 30.—A, Stump of appendix, grasped with a pair of forceps and crowded into the wall of the cecum; B, furrow in which the stump is buried.

A circular incision is now made, either by means of a sharp scalpel, or preferably by snipping with the points of the scissors, in the space between the two ligatures. (A, Fig. 28.) This should include the serosa and the subserous connective tissue. A cuff-shaped flap, (A, Fig. 29) formed of these structures, is turned back toward the temporary ligature until the latter is reached, precisely as the cuff-shaped flap in a circular amputation of an extremity is turned back to uncover the underlying structures. A ligature of fine, ordinary catgut is now placed around

the wall of the appendix at the bottom of and within the reflected cuff of serosa, and as nearly upon the same level as the temporary constricting ligature as possible. (B, Fig. 29.) The catgut ligature, here employed, should not be chromicized, but prepared without any hardening process; boiling in alcohol accomplishes the purposes of sterilization without materially altering the other qualities of the gut. This ligature is tied tightly and cut off close to the knot. Its purpose is to prevent hemorrhage from the cut surface of the wall of the appendix, as the latter is cut away, and to shut off the cavity of the cecum when the temporary constricting ligature is removed. The appendix is now amputated and the mucous membrane remaining in the stump (C, Fig. 29) touched with the thermo-cautery or fuming nitric acid. The best method of applying the nitric acid is by means of an inverted Hagedorn needle grasped in the

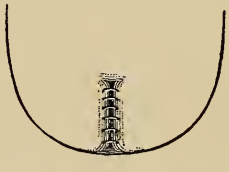

FIG. 31.—Furrow in the wall of the cecum sutured over the stump of the appendix.

jaws of a hemostatic forceps. The large eye of the needle holds just sufficient of the acid for the purpose, and by carrying the proper amount, and no more, to the point needed insures against bringing the parts adjacent to the stump in contact with the acid. The cuff-shaped flap is now placed over the face of the stump and the latter is grasped by means of a pair of dissecting forceps, and crowded against the wall of the cecum in such a manner as to form a furrow or depression in the latter (Fig. 30); the edges of the latter are sutured together over the stump of the appendix by means of a double row of Lembert sutures, so as to bury the latter out of sight (Fig. 31).

In the course of two or three days the ligature about the wall of the appendix, and which has been buried into the furrow with the stump of the latter, gives way. In the meanwhile the

sutured edges of the furrow have become strongly adherent, and there is no longer danger of escape of the contents of the cecum. This loosening of the ligature permits a smoothing out of the little dimple which took place upon the mucous membrane side of the cecum at the site of the former communication of the latter with the appendix, upon the application of the ligature. Finally, cicatrization at this point, conjoined with the thickening of the cecal wall resulting from the suturing together of the edges of the furrow upon the peritoneal surface, leads to a firm and solid condition of the intestinal tube at this point.

In cases in which the wall of the appendix is in a sufficiently good condition to bear the application of a ligature, and yet the surrounding structures, or the exigencies of the case from some other standpoint, will not permit of the manipulation necessary to

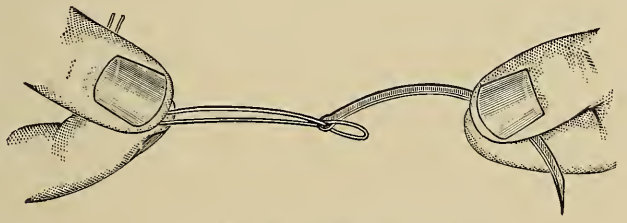

FIG. 32.—Manner of threading the needle.

carry out the above procedure, a ligature may be thrown about the organ at its base, including its serous surface, the organ amputated distad of this, the pouting portion of mucous membrane in the stump destroyed by the thermo-cautery or nitric acid, and the stump itself sunk into the furrow upon the peritoneal surface of the cecal wall, as just described. In the majority of cases operated upon during the active existence of the disease, this method of dealing with the appendix will constitute as near an approach to the typical procedure as it will be possible to accomplish. Its employment will therefore be more frequent than that of any other.

The meso-appendix should, as a rule, be dealt with separately. It will sometimes be found practicable to bring the stump of the mesentery where this has been tied off *en masse*, over against the site of the stump of the appendix so that its raw

surface is applied to the raw surface of the latter, thus doing away with the necessity of burying this in a furrow of the cecal wall.

This latter is a useful procedure, particularly in those cases in which a typical method like that above described cannot be carried out. In any event it insures a firm covering and more solid protection to the weakened wall of the cecum at the point from which the appendix has been removed, and, what is also of very great importance, by this method of technique the leaving of raw surfaces of peritoneum is avoided, and the formation of vicious adhesions leading to angulation of intestine, and subsequent obstruction prevented. A few Lembert sutures applied to the serosa adjoining the raw surface and covering in the latter will be necessary, in any event.

In cases operated upon early in the attack, as well as in the recurrent and certain of the chronic relapsing cases, section of the meso-appendix close to the organ, with clamping and ligature of all bleeding points, subsequently suturing together the edges of the divided serosa, constitutes the typical procedure in dealing with the mesentery.

If the base of the appendix is unusually broad, as in the fetal type, the appendix, together with a portion of the wall of the cecum, if practicable, should be excised, the edges of the opening being afterwards approximated, and a double row of Lembert sutures applied. Where the cecum is sufficiently free from adhesions to permit of its being brought outside of the peritoneal cavity, thus avoiding the risk of infecting the peritoneum by means of its contents, the latter procedure may be found an exceedingly useful one, even in cases of simple appendicectomy, the ordinary type of the organ being present.

If it is decided not to remove the appendix, its surroundings may be carefully disinfected, and the abscess cavity lightly tamponed with Mikulicz's wick-drains, which are always to be preferred, or drains made of iodoform or zinc oxide gauze.

When strips of gauze are used for tamponing they should have their edges folded in as follows : a strip of the material is taken and smoothed out ; each edge of this is now turned in in such a manner that both edges will meet in the middle ; the strip is again

folded, bringing the two doubled margins together; a running thread holds these folds in position. These strips are placed in position in an antero-posterior direction as regards the patient's body (anatomically speaking), and the strips systematically arranged in successive layers or folds, so as to effectually shut off the remainder of the peritoneal cavity, as well as to facilitate the removal of the gauze. My plan is to take a portion of the gauze strip and lay it in folds, the one upon the other, so as to make a drain sufficiently long for the purpose. This is placed in position in such a manner that when removed layer by layer, those layers which are farthest removed from the peritoneal cavity, and hence the nearest to the abscess cavity, are removed first. A number of these are sometimes required. The outer ends of the strips of gauze should be brought out of the most dependent portion of the external wound. The primary incision should be closed as much as possible, consistent with free drainage and the easy removal of the wick-drains, or gauze tampons. The advantage of the T-incision under these circumstances will be very great.

If the appendix is so situated as to admit of removal, the question must be decided whether it is best to close the wound entirely, or whether it shall be partially closed and the cavity tamponed. In coming to a decision, the extent of the infection, the completeness with which the cavity can be disinfected, and the size of the cavity are the chief considerations. Provisional sutures, designed to serve as secondary sutures, are placed in position, and left loose ready for tying when the proper time arrives. These provisional sutures are to be placed throughout the entire extent of the wound not closed at once.

The method of suturing and the material employed are of some importance. In order to obtain the advantages of the buried suture, to be enabled to remove the latter at will, and yet not be compelled to depend upon an absorbable material, always uncertain as to the length of time that it will efficiently hold the parts in apposition, I devised and have employed with great satisfaction for the past four years what I have called the "crossed suture." With this method of suturing, the different layers of the wall of the wound can be separately brought accurately in

apposition, each upon its own proper level, the thread being crossed over each layer in turn as it progresses from below upward from the deeper portions of the wound to the integumentary surface. Either silkworm gut, silver wire, silk or linen

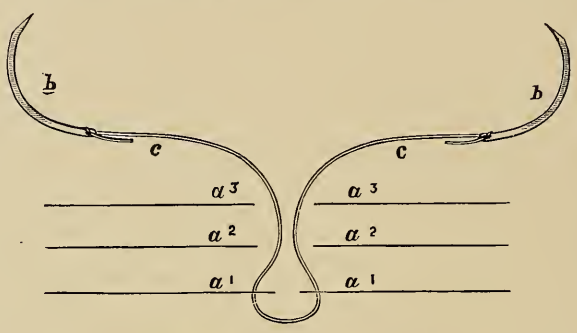

FIG. 33.—Showing suture passed through lowermost layer of "a." a^1 1st layer. a^2 2d layer. a^3 3d layer.

thread may be employed. The silkworm gut is to be preferred. The material is cut to lengths and the strand threaded with a needle at either end. The thread is secured in the eye of the needle by passing the end of the silkworm gut, which emerges as the needle is threaded, a second time through the eye of the

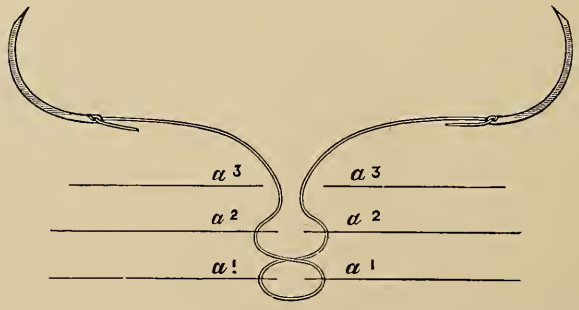

FIG. 34.—Showing suture crossed and passed through second layer, from below upward.

latter from the same side as that from which it was originally passed. (Fig. 32.) When the loop thus formed is drawn taut, the needle is securely held to the thread.

Both needles being secured to the thread, the former are

passed through the lowermost layer from below upward, one through each edge of the latter. (Fig. 33.) The thread is then crossed over the layer, the needles reversing positions. The needles are then passed through the next layer, are again reversed as regards position, thus crossing the thread again and over the second layer to be secured. (Fig. 34.) This process is repeated until all the layers are secured, the skin being the last to be included (Fig. 35), when the ends of the sutures are secured in the ordinary manner. In this manner the peritoneal surfaces

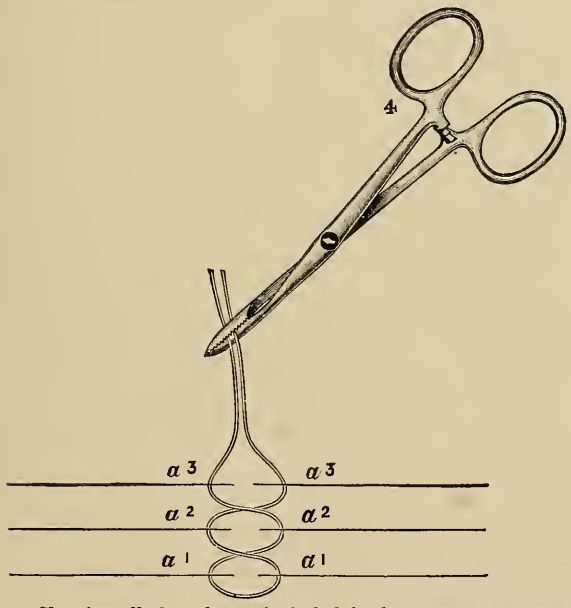

FIG. 35.—Showing all three layers included in the cross suture, ready for tying. "4," ordinary hemostatic forceps temporarily securing suture for ready identification until all are ready for tying.

are first secured, and then the muscular and fascial layers and skin, in turn.

The dressings employed in an aseptic case consist in a number of the yard squares, wrung out of the salt solution, crumpled and laid directly upon the wound. These are then covered with a thick layer of the sterilized cotton batting, and the whole secured in place by a binder with perineal straps, such as was described in speaking of the preparation of the patient.

CHAPTER XIII.

The After-Treatment.

In the great majority of cases of appendicitis operated upon in the early stage of the disease and prior to the occurrence of ulceration, perforation, gangrene, suppurative changes in the new formation-tissue about the appendix, or septic peritonitis, either local or general, the case will follow a practically afebrile and otherwise uncomplicated course, providing the surgeon has been successful in his endeavors to exclude infectious material from without during the operative procedure. The length of time required for the convalescence will occupy about three weeks under these circumstances. The same may be said of cases of chronic relapsing appendicitis operated upon in the interval of quiescence, as well as cases of the recurrent type of the disease, save that in the latter the possibility of removing the appendix through an exceptionally short incision will permit of the patient's resuming the upright position without fear of a resulting ventral hernia at a correspondingly earlier period (Morris). The cases are exceptional, however, in which it would serve the patient's best interest to permit him to bring to bear the pressure of the contents of the abdominal cavity upon the recently-united incision in the abdominal wall within a fortnight of the day of operation. A week longer than this offers advantages of a precautionary nature in the prevention of subsequent weakening of the line of union and a bulging at the site of the operation, even in the most favorable cases.

In cases operated upon later in the disease, in which most decidedly septic conditions are present, the after-course will be favorable in proportion to the efficiency of the natural safeguards in protecting the peritoneal cavity from invasion by infectious material prior to the operation, or the success of the surgeon's efforts in preventing infection, either from without or as the result

of removing the barriers in the form of adhesions about the appendix, which constitute the safeguards above alluded to. More or less drainage will be necessary in the majority of cases operated upon after the second day of the existence of the disease, as well as in not a few cases operated upon even prior to this time. I have never deemed it best to close the wound in the peritoneum in cases in which the slightest trace of pus or sero-purulent fluid was present, preferring under these circumstances to leave a few strands of wicking drain, at the very least, at one corner of the former. After a few days this may be removed, and if the portion of the wound still remaining open exceeds a half-inch in length, this may be closed by means of a secondary suture.

The question of drainage of effused serum from the abdominal cavity by means of catharsis is one of great importance, and should be most carefully considered by the surgeon. To attempt to drain in this manner too early may lead to disaster by breaking up adhesions not yet sufficiently well formed to bear the strain upon them involved in an active catharsis, while to wait until the serum has become a culture-medium for infectious agents from the original septic focus may permit the golden moment to slip by when benefit may be derived from such drainage. If the exigencies of the case and the character of the attack have permitted it, the patient's bowels will have been thoroughly moved before the operation as a part of the preparatory treatment. With or without this preliminary treatment, the surgeon will always feel a sense of relief when his efforts to secure a number of fluid movements by the use of saline cathartics have been successful. Under certain circumstances, however, as, for instance, where typical suture or ligature of the appendix has been impracticable, or in which the removal of the organ is not deemed safe, fecal extravasation, either from an insufficiently-secured stump or from a perforated appendix, is to be feared, and measures to prevent a fluid condition of the intestinal contents are indicated. On the other hand, where early movements are permissible or indicated, the longer this is postponed the greater are the chances of the occurrence of grave intraperitoneal septic conditions with their dreaded consequences.

In cases in which ample time has been available for purposes of preparation of the patient, physiological rest of the digestive tract and the use of a rectal tube or simple enemata to assist in expelling the intestinal gases are all that are indicated for the first twenty-four hours. The ingesta during this time is limited to an occasional swallow of water, preferably hot, if this does not provoke vomiting. The administration from time to time, as indicated, of a small dose of sulphate of morphia hypodermatically will assist the patient to bear the enforced abstinence from food if a craving for this is felt, and likewise allay any pain present. The occurrence of excessive vomiting or troublesome flatulence too high up to be relieved by the rectal tube or enemata, may require the use of lavage. This not only serves to rid the stomach of gas which has found its way into the viscus, but of accumulated viscid mucus. If lavage is practised soon after the operation, saliva loaded with the anesthetic agent, and which has found its way into the stomach, will be thus gotten rid of, and the effects of this, in prolonging the anesthetic effect, as well as provoking efforts of retching prevented. After the stomach has been thoroughly cleared out by the aid of the stomach-tube and a solution of boracic acid of the strength of three drachms to the pint, an occasional quarter of a grain dose of muriate of cocaine and five grains of oxalate of cerium will greatly assist in relieving the nausea. At the end of from twenty-four to thirty-six hours following the operation, in the class of cases now under consideration, the bowels may be moved by the administration of salines.

Where strictly local septic conditions are present, the same physiological rest should be given to the intestinal tract. An additional twenty-four or thirty-six hours should be allowed to elapse before commencing the use of cathartics, with the view of assuring sufficient strength to the adhesions about the septic focus to prevent direct infection of the peritoneum through rupture of these from forced peristalsis. In the mean while the use of the rectal tube, simple enemata, lavage, and other measures conducive to the patient's comfort should be employed, as in the first class of cases.

In cases in which general septic peritonitis is already present, it is imperative that whatever measures are calculated to give the patient the best chance for life should be instituted promptly. It is to be assumed that the vomiting following the anesthetic under these circumstances will be almost intractable and indefinitely prolonged. This, of course, will prevent the retention of cathartics, and greatly embarrass the surgeon's efforts to secure movements of the bowels. Lavage, while the patient is still under the influence of the anesthetic, may be easily practised if the head be sufficiently lowered to prevent whatever fluid which finds its way alongside of the tube in returning from the stomach from finding its way into the glottic opening. Following the lavage a full dose of sulphate of magnesium may be placed in the stomach through the tube while the latter is still in position. This will usually insure the retention of at least this first dose of the cathartic by the stomach. The persistence of the vomiting after the patient has recovered from the anesthetic will usually preclude the repetition of the dose of sulphate of magnesium, and some other form of cathartic may be tried. A pill which I have found useful, and which my hospital internes call the post-laparotomy pill, consists of colocynth, jalap, podophyllin and strychnia. If this pill is not retained, small doses of calomel may be tried in alternation with the pill. The preliminary administration of a combination of muriate of cocaine and oxalate of cerium will sometimes assist in the retention by the stomach of the cathartic.

In addition to the treatment of pre-existing septic peritonitis already laid down, its further management will be best conducted upon the lines laid down in the paragraphs upon septic peritonitis occurring as a complication following the operation.

The occurrence of post-operative peritonitis is of very serious import. It is impossible to lay down any hard and fast rule in the treatment of this complication. Free drainage through the intestinal canal, if this can be obtained without provoking or aggravating vomiting, offers the best chance to the patient in the very commencement of this complication; how difficult this is to accomplish those know only too well who have had much to do with this condition. Later on, the question of the employment of measures

to move the bowels must be determined by the conditions existing in each individual case. Overstimulation of the nerve-centres of the intestinal muscular apparatus by the too persistent administration of cathartics may easily do harm. The ice-coil, although its curative properties may have been greatly overestimated, should be employed on account of its tendency to relieve pain, if for no other reason. As a rule, its use greatly increases the comfort of the patient.

With the development of intestinal paresis increased difficulty in effecting movements of the bowels is experienced. Small doses of calomel in conjunction with, or alternating with, the sulphate of magnesium are sometimes useful. In connection with this, strychnia is given, hypodermatically, in $\frac{1}{20}$-grain doses, hourly, or even half-hourly, in extreme cases. Faradization, one pole being placed in the rectum, and the other spread over the abdominal surface or stroked along the course of the large intestine, has been of use in my hands. Half-hourly *séances* of ten minutes each are sufficiently frequent. The condition of intestinal paralysis, however, is usually a symptom of a general septic peritonitis, although it may occur in cases in which there is an absence of the usual symptoms of peritonitis. Under these circumstances it is probably due to septic conditions having their origin in the peritoneal cavity. The germs upon which the septic conditions depend may not as yet be demonstrable, but their toxic products probably exert their primary influence upon the muscular fibres of the intestinal tube. Whatever its origin, it will, in all probability, prove fatal, if the paralysis becomes complete. A general abdominal and pelvic septic peritonitis following appendicitis is, in my experience, an invariably mortal affection. Without exception, complete intestinal paralysis, occurring in connection with peritonitis, is the forerunner of a fatal issue. If intestinal paresis is not accompanied or followed by septic peritonitis, the use of small doses of opium should be resorted to, and all efforts directed to produce catharsis, save an occasional high enema or an ordinary low enema of a simple character, abandoned after the first, or at the most the second, attempt.

The occurrence of post-operative septic peritonitis is usually

postponed for from twenty-four to forty-eight hours following the operation, more frequently the latter. If more or less septic peritonitis is already present at the time of the operation, this interval, of course, will not be observed. The supervention of septic symptoms is exceedingly insidious. A gradual increase in the pulse-rate, and slow but persistent rise of temperature, particularly if these are conjoined with an obstinately constipated condition of the bowels, should always arouse suspicion. If vomiting sets in, both nourishment and medicines being rejected, and this be sufficiently removed, say by six or eight hours, from the vomiting resulting from the anesthetic, and, in spite of efforts to move the bowels no indications of passage of flatus from one portion of the tube to another are obtained, upon auscultation of the abdomen, the case is a hopeless one. From this time on the course of the case will be typical, as a rule. The stomach rejects everything placed in it. The accumulation of gas and some of the fluids swallowed by the patient leads to progressive and excessive distention of the abdomen. Cold, creeping sensations and profuse perspiration set in. The surface of the body is bathed in a cold, clammy sweat. Attempts to sustain the patient, by means of stimulating and nourishing enemata, prove futile for the reason that these are promptly rejected. Jactitation now comes on; the peculiar muscular pains of sepsis cause the patient to become very restless, and this, conjoined with delirium, may necessitate extra watchfulness to restrain him from springing from the bed. The vomited matter becomes dark brown. The anxious expression of the face gives place to one of apathy or absolute hopelessness. The temperature may rise to from 105° to 107° F., the pulse becomes too rapid to count, or it may be absent at the wrist altogether. The finger-nails become blue, the skin is a dark, muddy hue; moisture exudes apparently from every outlet upon the surface.

While the surgeon cannot be certain during the first forty-eight hours that anything is seriously wrong with the patient, the mere fact that no gas passes per rectum, that nausea is constantly threatening, and vomiting easily provoked will cause him some uneasiness of mind. If, in addition to this, the bowels do not move promptly, his worst fears are in a fair

way to be realized, and he will be impelled to redouble his efforts in this direction until either these are successful or until it is evident that intestinal paralysis is present and that they are not likely to prove successful. Under these circumstances continued stimulation of the motor-nerve apparatus of the intestinal muscular structure will not only prove futile, but probably harmful. If at the close of the second, or of the third twenty-four hours at the utmost, the patient's condition has shown no signs of a change for the better, all treatment should be abandoned, save that which is directed to euthanasia. In the mean time, and until it is evident that all efforts are useless, quinine in large doses, alcoholic stimulants, and strychnia should be given, either per rectum, if the latter will retain enemata, or hypodermatically. If efforts to produce catharsis have been abandoned early in the condition, the patient's sufferings may be very greatly ameliorated, and possibly benefited, by the administration of opium. This may be given in small doses at first for its stimulating effect; later on it may be given in larger doses with advantage.

I have never succeeded in improving a patient's condition in the slightest by reopening the abdomen, under these circumstances, with the view of irrigation and drainage. It will usually happen that when the diagnosis is sufficiently assured to warrant this the case has advanced so far as to render the procedure useless, and perhaps harmful by tearing apart adhesions and exposing new surfaces to absorption. I have even gone so far as to institute and maintain continuous irrigation of the abdominal cavity, but with no effect other than to increase the distress of the patient.

No hard and fast rule can be laid down governing the administration of cathartics, either in cases in which septic conditions already exist, or in the class of cases under consideration. The rational use of these, rather than their employment as a routine measure, should govern the action of the surgeon in each individual case. It should always be borne in mind that, while efforts are being made in this direction, incalculable harm may be done by too persistent endeavors.

If symptoms of mechanical intestinal obstruction develop, as evinced by absolute failure of gas to pass by the rectum, persistent, followed by fecal vomiting, progressive distention of the abdomen, prostration and signs of peristaltic movements obtained by the stethoscope applied to the abdominal walls, these should be met by a prompt reopening of the abdomen, and search for, and relief of, the imprisoned portion of the intestine. The obstruction is most frequently due to angulation, though ileus sometimes occurs. Cases will occasionally be observed in which the obstruction is due to mechanical causes, to which intestinal paralysis is added. Under these circumstances auscultation of the abdomen will not be available in differentiating these two conditions.

The occurrence of vicious adhesions may lead to intestinal obstruction, at a period of time comparatively remote from the operation, and even after convalescence has been thoroughly established. The following case illustrates this condition:

M. C., aged fifteen, was operated upon for acute appendicitis in my service at St. Mary's Hospital. The appendix was removed, and the abdominal wound was closed, with the exception of about an inch at the lower angle, where a small gauze drain emerged. The latter was dispensed with at the fourth dressing, and this portion of the wound rapidly healed by granulation. The portion of the wound that had been sutured united per primam. The patient was perfectly well, as far as the appendicitis was concerned, at the end of three weeks. Her mother gave her a banana to eat on the afternoon of the twenty-first day. After eating this she was seized with what appeared to be an attack of acute indigestion. During the night the abdomen became tympanitic, and vomiting occurred. This circumstance, together with the intractable character of the latter, and the failure to obtain a movement of the bowels, or even the passage of flatus by means of high enemata, demanded a second laparotomy. It was then discovered that a portion of the ileum had become attached by adhesions near the former site of the appendix. The adhesions were so placed as to bind down a loop of small intestine for a considerable distance towards the median line from the ileo-cecal valve. The ballooning of the intestine by the accumulation of gas, resulting from the attack of indigestion, had produced

a twist of a loop of intestine upon itself at its mesenteric attachment, thus causing both obstruction and rapid strangulation of the tissues of the intestine itself.

The general after-treatment, exclusive of complications, is that of abdominal section in general. The half-hourly administration of hot water in small quantities is to be followed in the course of twenty-four hours by half-ounce allowances of milk, at first peptonized and then plain. This is gradually increased to full milk diet in the course of the following two or three days; then farinaceous food and meat gradually leading up to full diet. If the patient's condition requires them, nutrient or stimulating enemata may be administered. Pain is to be controlled by hypodermatic injections of sulphate of morphia.

The external dressings should be removed and replaced by others as soon as soiled, in accordance with the rules governing the after-treatment of wounds in general.

In those cases in which adhesions are broken down, and the general cavity of the peritoneum opened, the wick-drains, or gauze packing which isolates the stump of the appendix and the site of the formerly existing purulent collection from the peritoneal cavity, should be left undisturbed for several days, until protective adhesions have formed beyond the gauze.

Where the abdominal wound is entirely closed at the time of the operation the dressings need not be removed until ten days or a fortnight have elapsed, at the end of which time the sutures may be removed. Exceptions may be found to this rule, in instances in which stitch-abscesses occur.

Where the wound is partially closed and provisional sutures are placed in position the latter may be drawn taut, so as to close the wound as soon as the septic conditions have passed away and healthy granulations make their appearance. A small opening may be left at the lower angle of the incision for drainage if a cavity is found to exist beneath the surface following the tightening and tying of the provisional sutures. If no provisional sutures have been placed in position, secondary suturing of the wound should be done as soon as it is in proper condition for the same. The

drawing together of the unclosed portion of the wound by means of previously-applied provisional sutures, or the application of secondary sutures, at as early a day as possible, will tend to insure the patient against the occurrence of ventral hernia as a sequel to the operative procedure.

In order to facilitate the removal of the gauze strips in cases in which it is found necessary to employ these, and to disturb the parts as little as possible while this is being done, it is best to remove the strips in the reverse order from that in which they were placed in position. In order to accomplish this with certainty these are numbered with India ink when they are made, and then used in regular order, or they may be knotted as they are used, the number of knots serving to identify them. Wicking may be removed a single strand at a time.

After the withdrawal of the drains a light packing of gauze may be placed in the superficial portion of the wounds. The spaces formerly occupied by the drains will have been filled by the return of the coils of intestines which have been displaced by the presence of the former. Upon the occasion of each subsequent redressing a progressively lessening of the amount of packing required will be observed, until finally granulations will spring up and either strapping, or preferably secondary suturing, can be applied.

Fecal communication between the cecum and the wound-cavity may occur during the after-treatment. In one case in my hospital service, a communication between the wound-cavity and a coil of small intestine also occurred, but in this case tubercular ulceration was supposed to have been the cause. Fecal communication usually has its origin in some condition of the vermiform appendix, which prevents the proper application of the ligature at its base. The occurrence of this accident in a case in which the abdominal cavity had been entirely closed would lead to fecal extravasation and the most disastrous consequences. Its occurrence is usually limited, however, to the very class of cases in which entire closure of the abdominal wound is contraindicated, namely, a septic condition of the appendix and the surrounding parts.

I have never known a fecal communication of this kind to lead to a permanent fecal fistula. With due attention to the cleanliness of the wound and encouraging healthy granulations, together with care in securing frequent movements of the bowels by enemata (two or three times daily), all of the cases in which this accident has happened have terminated in complete closure of the fecal communications before the final closure of the remainder of the wound itself. Where the fecal communication is due to ulceration of the wall of the intestine at a point other than at the site of the appendix, a secondary plastic operation may be required for its closure.

Mucous Sinus.—The occurrence of a mucous sinus has been met with occasionally. This results from a failure, either to completely cover the mucous membrane left in the stump of the ligated appendix, or to destroy it altogether. In my earlier operations I relied upon the application of pure carbolic acid to the stump, and in some of these a mucous sinus persisted; in one case this closed and opened several times. Permanent closure was finally effected after thorough curetting and the injection of equal parts of carbolic acid and tincture of iodine. Simple curetting, although thoroughly done on several previous occasions, had failed.

Ventral Hernia.—This has been observed in a certain proportion of cases to follow operations for appendicitis. The necessity for leaving open a portion of the abdominal wound probably gives rise to this most frequently. I have endeavored to prevent the occurrence of this complication by keeping the patient in the dorsal position for about six weeks in order to secure as much stability in the scar tissue as possible. In many cases in which the abdominal wound is closed at once, probably less than half of that time will suffice. Some form of abdominal support should subsequently be worn, particularly by those who are compelled to maintain the upright position during the entire day.

In cases where the abdominal wound is not closed immediately it will be subject to the same interruptions of the healing process as other wounds exposed to infectious influences. In the

following case the healing process seems to have been complicated by the presence of a micro-organism to which, as found in man, destructive pathogenetic properties have not heretofore been ascribed:

A. M., aged thirty-five, male, was admitted to my service at St. Mary's Hospital, with the history of having been attacked in the early hours of the morning of the previous day by all of the symptoms of acute appendicitis of an unusually severe character. A right lateral laparotomy revealed an appendix whose distal two-thirds was completely gangrenous. It was buried in a mass of adhesions which had also taken part in the gangrenous process. The appendix was ligated at the base, and excised. Unfortunately the circumstances surrounding the operation were such as to prevent a proper bacteriological examination. On the second day an elevation of temperature necessitated a redressing of the wound. It was found that the gangrenous process had extended from the cavity to the edge of the wound, and thence into the abdominal parietes towards the umbilicus, involving a space as large as the palm of the hand. The area of gangrene was marked by an irregular outline, numerous blebs, and considerable infiltration of the tissues. Stab inoculations in a sterilized agar-gelatine tube were made, and pure cultures of the *bacillus pyocyaneus* of Gessard were obtained from the depths of the integumentary tissues.

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